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Electromagnetic Radiation. THE remarkable experiments of Prof. Hertz on electrical radiation have attracted so much attention, and we have commented on them so often that a general résumé showing the nature of all the fundamental experiments on electromagnetic radiation should have a special interest for our readers. Many of them have been referred to before in our columns, but a general description will nevertheless prove convenient, especially in view of the fact that we recently published Prof. Hertz's own theoretical deductions based upon them. Unfortunately most of them are of a nature rather difficult of illustration before a large audience; they are, for the most part, experiments rather for the laboratory than for the lecture room; nevertheless they are of such fundamental importance that they should find a place in every course given to students on the science of electricity, and are well worth repeating for self-instruction by those who have already passed their student days and are engaged in the more active pursuits of practical electricity. To those who desire to investigate the subject further we can do no better than recommend the chapters in Fleming's "The Alternating Current Transformer," dealing with the topic; and, also, the researches that from time to time have appeared in the *Philosophical Magazine*. Meanwhile we shall endeavor to keep our readers thoroughly posted on the later investigations along a line that promises so much for the future of electrical science.

Electric Rapid Transit. OUR cable despatch this week contains information that we commend to the careful consideration of all who are interested in rapid transit in this city. The City & South London Railway, that remarkable underground electric road that has been in such successful operation for a few weeks past, is preparing for considerable extensions, and its excellence seems to have stimulated similar enterprises. The situation at present in New York is rapidly becoming intolerable, and it is high time that active measures were taken to secure something like an adequate system of fast trains to relieve the city from its present difficulties. There can be no more striking evidence of the necessity than a glance at the upper end of Manhattan Island from the Palisades opposite the mouth of Spuyten Duyvil Creek. Standing on the brink of the cliff it is hardly possible to imagine that one is on the outskirts of a gigantic metropolis. Scattered houses and apparently small villages are visible beyond the Hudson, but one has to look miles to the southward, where the smoke cloud hovers over the city to realize that he is really just across the river from the metropolis of America. The upper part of New York City is practically deserted and undeveloped, simply because it is inaccessible from the business districts. The enormous population has overflowed into Brooklyn, and across to New Jersey, rather than northward. A large number of plans have already been proposed, some of them of enormous difficulty, others more practicable; none of them that we have seen yet seem more feasible, however, than the construction of a system similar to that of the City & South London Railway, of which we have been speaking. The tunnels required in this case were only 11 ft. in diameter, and they were actually constructed without disturbing the streets in any way, and almost unknown to the busy city above. No formidable engineering difficulties stand in the way of a similar enterprise here, and there is hardly any reason to doubt that it would not only be thoroughly successful as a solution of the problem in hand, but would pay from the very start. It is far and away the simplest method of underground rapid transit construction and would involve neither enormous damages paid the property holders, as would be necessary in the case of a viaduct, nor an elaborate substructure that would necessitate tearing up and reconstructing the most important streets in the city. Several admirable suggestions as to available routes for underground service have already been made, and it is high time that some action should be taken in the matter.

Telephone Rates. IN view of the large rentals charged or telephone service in this city, one cannot help contemplating with something of envy the results that have been reached under government administration in Germany. The telephone service of Berlin is extensive, and has proved on the whole satisfactory to the subscribers. The city itself, as is well known, is very nearly the size of New York, and decidedly less compact; yet the yearly rental charged by the government is only 150 marks, about $37.50. Where more instruments than one are placed in a building even this rate is much reduced. The government administration has proved efficient and is now extending to the establishment of a good system of long distance telephone service. At the present time Berlin is in regular communication with Bremen, for example, about the same distance from that city as Boston is from New York. There is, however, a striking difference in the rates charged there and here, for the Berlin-Bremen service is furnished at from 25 to 50 cents per message; a sum in sharp contrast with the $2.50 for five minutes conversation charged here. We are by no means in favor of government control of telegraph and telephone lines in this country. The conditions are very different from those that exist under an imperial government, and much less favorable for an economical administration. Nevertheless the great difference in charges for telephone service which we have noted is not a pleasant subject for contemplation. Of course, in this country there has been rapid extension of lines, and heavy expenses of various sorts have been necessarily incurred by the telephone companies; yet the rates now charged could be much reduced and the business would still yield a good profit, at least what would be considered a good profit in any business that does not partake of the nature of a gigantic monopoly. Possibly after the expiration of the fundamental patents on the telephone there will be enough competition to bring the telephone service down to a point where rentals could be paid without inward grumbling; and the moral that we would draw from the German figures above mentioned is not that the government should take possession of the telephone lines, but that the telephone companies themselves should quiet any further agitation for a postal telephone system by giving the public cheaper and better service than ever before.

A Successful Accumulator Plant. THE use of storage batteries for electric lighting is by no means so common in this country that a plant thus equipped is a familiar sight, even to electricians. On another page we have, therefore, thought it desirable to illustrate one of the most successful storage battery stations with which it is our good fortune to be acquainted. For office buildings like the one in which this plant is located the accumulator possesses peculiar advantages. It is usually both expensive and undesirable to operate an isolated station all night, and in very many buildings such a necessity arises unless it is found economical to use gas during the evening hours. Where there is electric light at all times except when it is most needed tenants will naturally be somewhat dissatisfied. The use of the storage battery avoids the inconvenience of all-night service in a dynamo room so simply and conveniently that it would be used for isolated plants much more frequently than it is, provided the public could be satisfied that it is to be depended upon. Abroad, notably in England, this fact has been demonstrated long before this, and the storage battery is very frequently employed as an adjunct to the lighting plants in large buildings and residences. The experience of the Schermerhorn Building, which we describe, ought to convince our readers that electric lighting by accumulators is not only practicable but economical. For a large battery to endure constant service at a discharge rate higher than the normal for 18 months, and to do this without breakdown and without needing replacement of any part of the accumulators, is certainly a most creditable record, and speaks volumes for the endurance of the cells, as well as the care with which the plant has been operated. Such an extended and successful experiment as this ought to afford convincing proof of the practicability of storage battery lighting. Of its convenience we need say little here. It is manifestly a great advantage to dispense with night service in the engine room, both as a matter of economy and as a matter of convenience. In private houses isolated electric lighting is almost impracticable, except for the accumulator, for there are very few cases in which a plant could be operated all night without inordinate expense, and at the same time it is most inconvenient to be deprived of light at any time that occasion may render it necessary. Those having charge of isolated plants may well profit by the lesson of the Schermerhorn Building, and at least investigate the merits of the accumulator as an adjunct to their present plants.

Electric Lighting in London. ON another page we give in complete form a most important paper on the electric lighting of London. We sometimes are inclined to think that our English cousins are behindhand in matters electrical, and in certain developments the criticism is a just one, but it should be remembered that in spite of the red tape that has stood in the way of very many improvements electric lighting in the metropolis of England is carried on on an enormous scale; and electric rapid transit, which is here only a dim hope of the future, is there an accomplished fact. From the figures given by Mr. Bailey in his very interesting account of the work done by the various London electric lighting companies it is seen that there are about 180,000 incandescent lamps supplied by central stations in London, while the number of private plants brings the grand total up to over a quarter of a million. A glance at his table showing what is done by the individual companies furnishes abundant food for reflection, and affords a sharp contrast to our own methods. In the first place it should be noted that by far the larger part of the work of lighting London is by alternating currents; of the remainder a very large proportion is by direct currents supplemented with storage batteries, and only a little over 30,000 lights are supplied by the ordinary direct current method. Here in New York the statistics are quite reversed, and the storage battery, useful as it has proved itself abroad, is conspicuous by its absence. In making any comparisons, however, between electric lighting in New York and London, it ought to be remembered that the 180,000 lamps in the latter city are calculated in 8 c. p. lamps, or their equivalent. The 8 c. p. lamp is almost unknown in this country; it has been tried a few times, but without success. The 16 c. p. lamp is the standard here, and those of lower power are scarcely used at all, although they might be applied with great advantage in many cases of house-to-house lighting. Another noticeable fact in the London lighting system is the very general use of meters, of which no less than eight varieties are employed, a considerable proportion of them, we may note with satisfaction, being of the Westinghouse type. A large amount of the distribution is still accomplished by overhead wires, and little or no trouble is reported from their use, though, as will be seen from the tables, the underground conduit is coming into use to a considerable extent. Altogether the amount and character of the work that has been done in London is exceedingly creditable, and in spite of the conservatism of our English friends they seem to have grasped the situation in a way with which even a Yankee might be well contented,

Latest Foreign Electrical News.

(By Cable from Our Regular Correspondent.)

LONDON, Jan. 5, 1891.—The success of the City and South London Railway has stimulated progress in the direction of electric traction, and there are now three electric railway bills announced that will facilitate important extensions. The City & South London Railway, besides pushing its line further southward, will run an extension north, so that the total length of the system will reach six miles. Work on the southern end of the line is already in progress. Aside from this several lines are proposed, one of them six miles long from the east to the west side of the city, and there is now under construction an electrical tramway on the Lineff system three miles long.

Electric lighting is also on the increase. The St. Pancras municipal station is rapidly nearing completion, and, in short, everything electrical seems to be progressing with commendable rapidity.

The presidential address of Prof. William Crookes, F. R. S., recently elected president of the Institute of Electrical Engineers, will be delivered at the meeting on the 15th of this month.

The Budapest Electric Tramway System.

In a pamphlet just issued by Messrs. Siemens and Halske the following particulars of their electric tramway on the open conduit system now in operation at Budapest are given. The channel has a uniform breadth of 11.2 inches. The slot giving access to the conductors is placed in the groove of one of the running rails, so that there is no more metal exposed in the roadway than is the case with horse tramway lines. At intervals of four feet along the channel, iron chairs 7.2 inches broad serve to support the running rail, and also to carry insulators, to which the conductors are attached. The bottom of the chanrel, which is formed of concrete, is at a depth of 22.8 inches below the surface of the roadway, and the slot between the rails which form its roof is 1.3 inches wide. The conductors, of which there are two (positive and negative), consist of angle iron, and are placed at the sides of the channel so as to be out of sight and out of reach. The cars carry a single motor, geared to one of the axles, and four groups of resistance frames for regulating the speed. The current is supplied at a pressure of 300 volts.

Three lines with an aggregate mileage of five and a half miles are at present in operation on the above system. A fourth line is at present building, but on this an overhead conductor is to be used. At the central station there are at present three 100 h. p. compound engines, each driving a dynamo by means of rope belts. A speed of nine and one-third miles per hour is allowed, and at certain parts this may be increased to over 11, while at others it has to be reduced to six and to six and three-quarters. The day's work ranges from 75 to 95 miles per day per car.

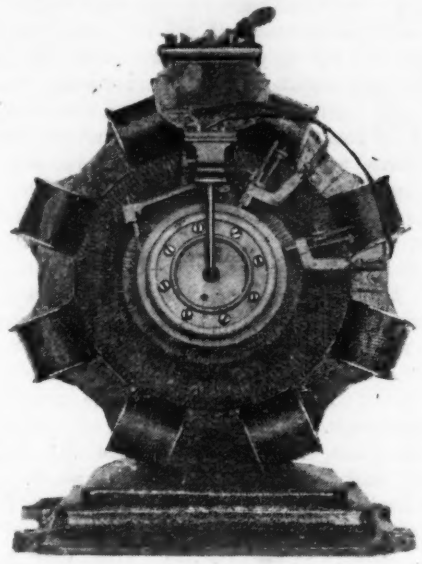
The New Baxter Multipolar Stationary Motor.

This motor, which we illustrate herewith, is the latest machine brought out by the Baxter Motor Company. It is designed for slow speed, and will run at velocities ranging from 900 for the smallest sizes to about 400 for the largest. It is an eight-pole machine, the field being built up of eight magnets, forming consequent poles. The magnet cores are laminated, and are clamped together so as to form a rigid ring, almost as much so as if they were made of one solid piece. This field ring is secured to the frame of the machine by four stout bolts attached to the poles of similar sign. The armature is a tooth "Gramme" ring, and the total air space is very small, being but a small fraction of an inch. The magnetizing force required to saturate the field in the 10 h. p. motors is less than 4,500 ampère turns. The shaft runs in two large bearings in the centre; the driving pulley is placed at one end, while the armature is at the other. The bearings are both in one solid frame, so that it is impossible for them to get out of line; the shaft is made of sufficient size to prevent springing, and the machine is said to run without any tendency whatever to develop heat in the bearings. By this construction the machine can be easily taken apart. All that is necessary is to take off the pulley and the brush holders, then the armature, and shaft can be removed at once.

The Baxter Company expects to make this type of machine in all sizes from three horse power up, and the same design with the addition of an outside bearing for the pulley end on the shaft will be used in the company's large generators for railway work. Several small motors of 10 h. p. and under, and generators of 75, 100 and 125 h. p., intended for railway work, are now under way. These generators will either be compound wound or separately excited. The Baxter Company advocates the separate exciter, where it is desired to obtain the very best results. Although the speed at which the machines run is very low, their efficiency is said to be very high, and the output per pound of weight is, as might be expected, greater than can be obtained with the ordinary two-pole machines.

It is stated that the company's eight h. p. 500 volt machines, which revolve at 800 revolutions per minute, will weigh complete a little over 500 pounds, and the electrical efficiency will be over 95 per cent. The 75 h. p. generator, which runs at 500 revolutions per minute, will have an electrical efficiency of over 96 per cent., and will weigh about 6,000 pounds. This generator has an armature 24 inches in diameter with a 9-inch face, and will be driven by a 14-inch double belt. The shaft will be 4½ inches in diameter and of hardened steel.

Mr. Baxter was one of the first American electricians to recognize the merits of the multipolar machines, and it may be remembered by our readers that we gave a description of one of his motors in the columns of THE ELECTRICAL WORLD of Sept. 28, 1889. The perfection in the design of the present machines, which is well exhibited by the illustration, shows that he has given the matter careful attention, and is determined that his company shall keep among the foremost establishments in the electrical field.



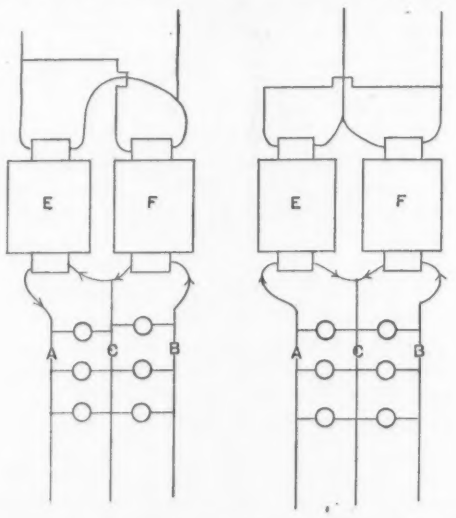
THE BAXTER MULTIPOLAR MOTOR.

Coupling Transformers on a Three-Wire System.

BY A. L. PIERCE.

I have been carrying on some experiments in coupling transformers on a three-wire system, the results of which may be of interest to the readers of THE ELECTRICAL WORLD.

In some cases, perhaps, it will be advantageous to couple transformers in the following ways: In Fig. 1, the arrowheads show the direction of the current at the same instant on the three wires. It will be seen that the transformers are connected in series as are the generators on the Edison three-wire system, and therefore we can see the same saving in copper since the wiring is done for double the pressure. The regulation is as nearly automatic as could be wished. If we connect a Thomson watt-meter coil in series with wire *c* and the armature in shunt to *a*, if we have an equal load on each side the meter will not register. If we have more on *E* than *F* the meter will register accurately all in excess of *F*. If now we put more lamps on *F* than on *E*, the meter will reverse and register in the same proportion as it did in the first case, only backwards. To measure the



FIGS. 1 AND 2.—TRANSFORMERS ON A THREE-WIRE SYSTEM.

current used at the transformers it will be necessary to connect a meter in series with wire *a* and one to wire *B*. If current is sold to a number of customers, the connections can be made as they would be from a separate transformer. In Fig. 2, if we want to measure the total amount of current we connect our meter in series with wire *c*. If now we put an ammeter in circuit with *a*, *c* and *B*, *a* and *B* will show the load of its transformers *E* and *F*, *c* will give the total equal to *a* + *B*, and we also see that wire *c* will have to be of twice the carrying capacity of *a* and *B*. The regulation is the same as Fig. 1.

In comparing the two ways it will be seen that Fig. 1 is the better system in most cases, and is the better for wireing for large halls and theatres, as it not only saves in copper, but we have two main fuses to depend on instead of one, as in the two-wire system. The transformers can be run in parallel, any number on a side to suit the conditions of the load. In Fig. 2 the total number of lamps can be lighted or extinguished at once with a single pole switch on the centre wire c. In each case, with one lamp on one side and the full capacity of the transformer on the other side, there could not be detected any difference in the brilliancy of either side.

The Design of Dynamos and Motors.

BY JOHN BEATTIE, JR.

THE ELECTRICAL WORLD of April 28, 1888, contains an article entitled "A Practical Method of Calculating and Designing Dynamos and Motors." The rule given therein for calculating the E. M. F. in any machine is as follows: Multiply $\frac{3}{100}$ volt by the cross section of the armature core in square inches, and by the number of convolutions of wire in series with each other, and by the number of times that 1,000 reversals occur in one minute. In the case of a Siemens armature, the cross section to be used in this calculation is the *full cross section of the armature core.*

The rule as far as it relates to the Siemens armature is incorrect. In Carl Hering's "Principles of Dynamo Electric Machines" there are descriptions of seven good machines with Siemens armatures for which the above-mentioned rule does not work. In "Dynamo-Electric Machinery," by Silvanus P. Thompson, the rule seems to apply to the Edison-Hopkinson dynamo, but upon close inspection and analysis and application of a better rule—better because correct—it will be found that the "Crocker" rule does not apply and is incorrect. In the following typical cases the correctness of my statement may be verified and the application of a correct rule seen.

CASE 1.—*Manchester dynamo*, Gramme armature. Sixty wires × 30 square inches × $\frac{8}{1000}$ × .03 = 113.4 volts or 110.5 by the book. A slight change in the cross section of the armature or in the speed would make the difference of 2.9 volts. In each foot of active wire between one pole piece and the armature there was induced 2.45 volts at a speed of 56 feet per second. There were 30,440 lines per square inch cut by the active wires. It took 446 ampère feet of magnet wire per square inch of field magnet and 235 ampère feet of magnet wire per square inch of pole piece to force the lines across ⅝ inch of air space.

CASE 2.—*Edison-Hopkinson*, Siemens armature. Twenty wires × 120 square inches × $\frac{1800}{1000}$ × .03 = 115.2 volts. Core discs, 9.68 inches in diameter; shaft, 3.02 inches in diameter; cross section, 18 × 6.666 = 120 square inches. Let us now take one-half the above cross section, namely, 60 square inches and substitute it for the whole cross section of 120 square inches.

Twenty wires × 60 square inches × $\frac{1800}{1000}$ × .06 = 115 volts.

Let us see what that double decimal means, and see why we take the cross section of the armature the same way that we do in the case of the Gramme ring. In the Siemens armature the shaft is insulated from the core discs, and the lines have two paths from pole piece to pole piece, the same as in the Gramme armature. This last case was a slow speed machine, 36 feet per second for a 10-inch armature. It had a small amount of active wire, 45 feet, and required an intense field, which it had. The number of volts per foot was 2.55, the speed was 36 feet per second, and at 49,280 lines per square inch it required 607 ampère-feet per square inch of the field magnet core to force the lines through ⅝-inch of air space between pole piece and armature. Crocker's rule correctly stated is as follows: Multiply the cross section of the armature core in square inches by the number of convolutions of wire in series with each other by the number of times that 1,000 reversals occur in one minute and by a decimal that depends upon the magnetization. The nearer the armature can be placed to the pole piece, and still have the armature revolve freely, the less wire will it be necessary to use on the field magnets in order to make the decimal .03 or greater. It does not require a large amount of wire to get 10,000 lines per inch in wrought iron, but the air space takes compound interest. Carl Hering's rule for calculating E. M. F. as given in his book, referred to above, will be found very satisfactory. Remember that if the requisite number of volts is not produced a few more or less revolutions per minute makes a great difference. I built a small dynamo not long since designed to light ten 16-candle 3.1 watt lamps at 57 volts, using Hering's rules. It does its work without sparking, and does not require any change of brushes from no load to full load. The armature is six inches long; discs, two and seven-eighths inches in diameter, and the shaft one inch in diameter. The armature has 36 sections, with four wires to a section, and has a speed of 34 feet per second. The formula gives 5,073 × 72 × $\frac{5200}{1000}$ × .03 = 57 volts at full load. Fifty feet of active wire gives 1.14 volts per foot, and at 34 feet per second it gives 23,284 lines per square inch.

High Speed Electric Railways.

Professor William D. Marks lectured at the Franklin Institute, Philadelphia, recently upon the subject of electricity as a motive power, taking as his topic the words "Two-and-a-Half Miles a Minute," a quotation from a prediction that he had made to the effect that that rate of speed would be attained, possibly ten years from now, certainly in twenty years.

He said the effect of such a speed would be to relegate steam locomotives to the scrap heap and to revolutionize

the present form of rolling stock and the mode of railway construction. The limit of speed has now been reached with steam as a motive power, and that limit is but a comparatively small advance from what was accomplished by the very early types of engines. The lecturer thought there was no force in the objection raised by railroad men that no one would be found willing to travel at such a high rate, and that people would soon get used to it. The advantages in prolonging the working hours of a man's life, etc., would soon commend it as a necessity of the times.

Professor Marks sketched briefly the history and progress of the electric locomotive, beginning with the Siemens system, first tried in Berlin, and referring to the overhead trolley system, storage battery cars and the system by means of underground conduits. As to the storage battery car, he said there could be little doubt a battery would ultimately be perfected which would serve the purpose, but that it is not likely that it will prove as cheap as the use of the direct current. The storage plan, he thought, was cheaper than horses, but the dynamo will beat the storage battery. As to the underground conduit plan, he thought one could be devised which would be easily accessible for repairs and would not cost over $30,000 a mile, while the power ought to be produced at a cost of not over five cents per horse power per hour, including all clerical and administrative expenses.

The lecturer touched briefly also upon the elevated and underground systems of rapid transit, holding, with reference to the former, that there was no reason why the elevated railway should be made such a horror as it is in New York. Different methods of construction and the use of electric motors would obviate much of the present annoyance. With reference to the high speeds of which he had spoken, Prof. Marks said that they could only be attained by electricity, and that it would involve essential changes in roadbed, rolling stock, etc. After pointing out the advantages of a system of electric motors, Prof. Marks said he would not hesitate personally to drive a motor from here to New York at the high speed he had named—2½ miles a minute.

The Alkaline Accumulator.

The alkaline accumulator devised by MM. Commelin Desmazures, and Bailhache, according to the London *Electrician*, has recently undergone a small improvement in detail, which will tend to diminish the somewhat excessive loss of charge when left on open circuit, which was noticeable in the earlier types. A battery of these cells, weighing 21,650 pounds, is used on board the marine boat "Gymnote," and it has been found possible to obtain from this battery, without injury to it, no less than 345 horse-power hours, or one horse-power hour per 63 pounds of dead weight. A battery of these cells was also employed to operate a Canet cannon during the Paris Exhibition last year. The Commelin-Desmazures accumulator contains, it will be remembered, compressed porous copper negatives (2 to 3 millimetres thick), inclosed in an envelope of parchment cloth, and iron wire gauze positives, in a 50-degree Baumé solution of zincate of potassium. During the charge zinc is deposited upon the iron electrodes, and oxygen is absorbed by the copper electrodes. During the discharge the zinc is redissolved, combining again with the oxygen from the copper electrode. The average E. M. F. per cell is only .75 volt. It was found that the parchment cloth became feebly conducting after long immersion in the electrolyte, and in consequence there was considerable loss of charge on open circuit. The cells are now constructed with the parchment cloth carefully insulated from the copper plates.

A Successful Storage Battery Plant.

The use of the storage battery as an adjunct to the dynamo in electric lighting installations has not become, in this country at least, as general as its success in stations that have given it a trial would seem to warrant. There are, however, a few plants which have demonstrated by actual operation the economy of this method of supplying electric current for incandescent lights. One of these, which has been in continuous service now for more than eighteen months, is that illustrated on this page, an installation that is supplying current for the lights of the Schermerhorn Building at 96 Broadway, in this city.

In this plant the contract called for a battery sufficient to light 37 lamps for 10 hours at a pressure of 75 volts, each lamp requiring three-fourths of an ampère, or 74 lamps for four hours. Ninety cells of the Anglo-American type were selected for this purpose. These were connected in three series of 30 cells each for charging and in two series of 45 cells each for discharging. The cells were arranged in cupboards along one side of the dynamo room as shown in the illustration. The dynamo used for lighting and for charging was a Thomson-Houston 80-volt, 200-light machine and was run during the day on 110 to 120 lights. Before the batteries were installed the dynamo was run 10 hours a day. The capacity of the cells was 150 ampère hours, the rated capacity of the two series of 45 each as arranged for the discharge being 300 ampère hours.

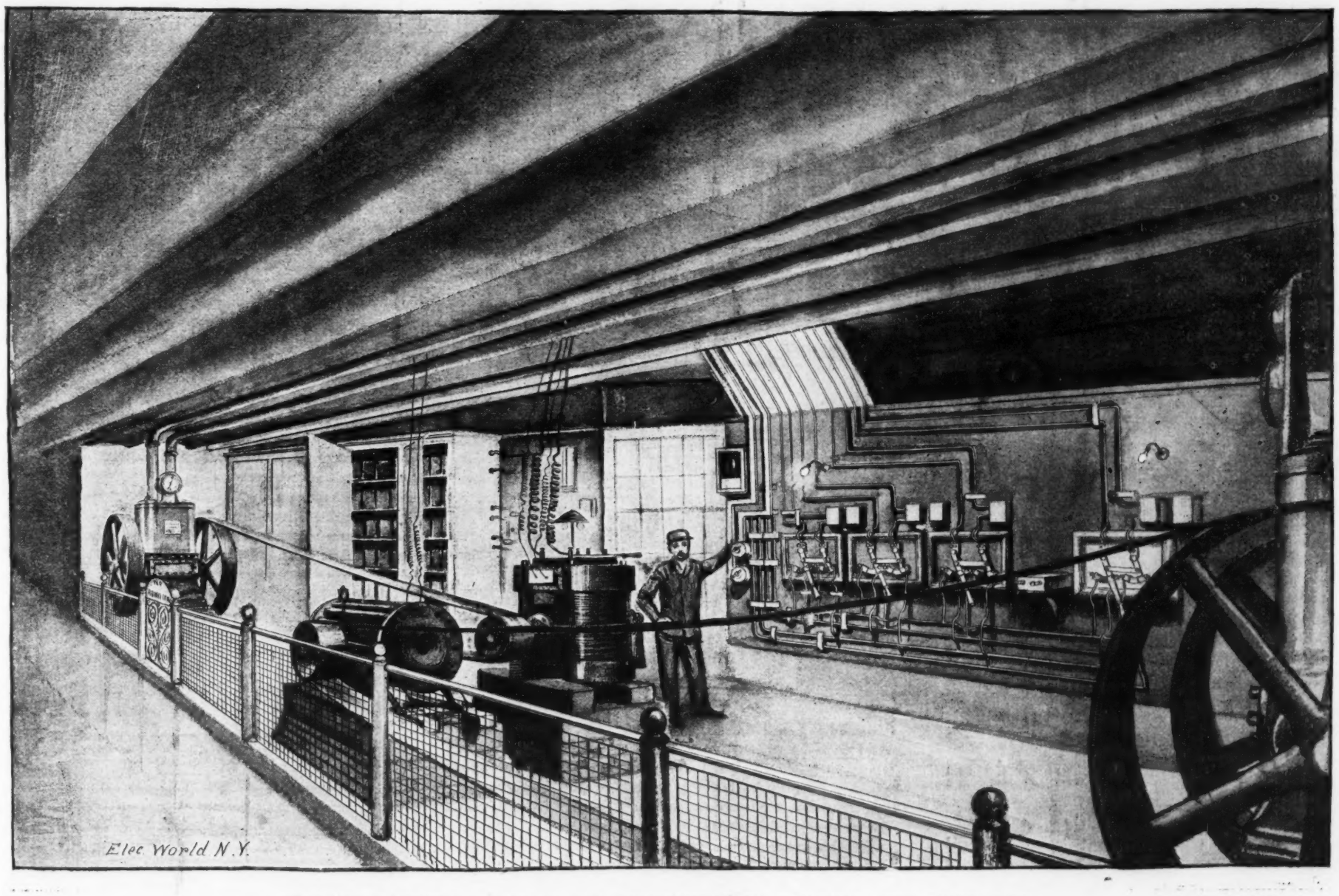
Discharging was commenced May 23, 1889, and on the second night the cells were drawn upon to the extent of 295 ampère hours. As soon as the storage battery was put on the circuit the engine, boiler and dynamo stopped running one hour earlier, and at the beginning of the second week another half hour earlier, and each succeeding week a half hour earlier still, until the 21st of June, when half-past four was reached. After that time their maximum running was seven and a half hours each day, and the lamps were lighted from the batteries sixteen and a half hours, while on Sundays and holidays they were lighted forty hours. The record of ampère hours drawn from the cells for two months is given in the table below:

May	29	to	May	31	388	ampère	hours.
"	31	"	June	1	338	"	"
June	8	"	"	10	342	"	"
"	15	"	"	17	403	"	"
"	22	"	"	24	373	"	"
"	26	"	"	27	302	"	"
"	27	"	"	28	296	"	"
"	28	"	"	29	292	"	"
"	29	"	July	1	407	"	"
July	1	"	"	2	345	"	"
"	2	"	"	3	331	"	"
"	3	"	"	5	443	"	"
"	6	"	"	8	407	"	"
"	9	"	"	10	301	"	"
"	11	"	"	12	304	"	"
"	12	"	"	13	331	"	"
"	13	"	"	15	403	"	"
"	15	"	"	16	323	"	"
"	19	"	"	20	297	"	"
"	20	"	"	22	401	"	"
"	25	"	"	26	326	"	"
"	26	"	"	27	335	"	"
"	27	"	"	29	407	"	"
"	30	"	"	31	294	"	"

This will give an idea of the extreme discharges that were taken from the batteries until the latter part of October, when the engine and dynamo were kept running until six o'clock, so that the exhaust steam might be utilized for heating the building. No limits have ever been made on the discharging capacity of the battery, so that it has been run on a commercial basis without any restrictions.

From an economic standpoint the batteries have saved to the owner of the building, Mr. Astor, two and a half hours running of engine, dynamo and one boiler each day, one ton of coal per week, and a hundred dollars a month gas bill.

In the illustration is shown, besides the accumulators ranged in their cases, the dynamo and engine plant. This is all located in the basement of the building and is kept in excellent shape by the engineer in charge. A 350-light Loomis dynamo is directly belted to a Westinghouse engine, and the Thomson-Houston dynamo mentioned above is also driven by a Westinghouse engine. The belts for the plant were furnished by the New York Belting and Packing Company of this city. The switchboard which controls the lighting circuits of the building is provided with switches so arranged that any one of the four circuits of the building may be independently controlled. The switches for shifting the battery connections for charging and discharging are upon a separate board. Altogether the plant is well and compactly arranged and has been remarkably successful. The cells, which were installed by Mr. L. Morse, of this city, have proved to be very durable and of great service in decreasing the cost of lighting in this plant to the lowest possible figure.



STORAGE BATTERY PLANT IN THE SCHERMERHORN BUILDING, NEW YORK CITY

Electrical Distribution by Transformers from Central and Eccentric Stations.*

BY DR. J. A. FLEMING, M. A.

Systems of Distribution—Compensator System.—This system of distribution for incandescent lighting by alternating currents is the invention of Prof. Elihu Thomson, and was introduced before the transformer system had attained much commercial expansion. The principle of the system is shown in Fig. 5. An alternating current generator usually wound for a potential of 330 volts delivers

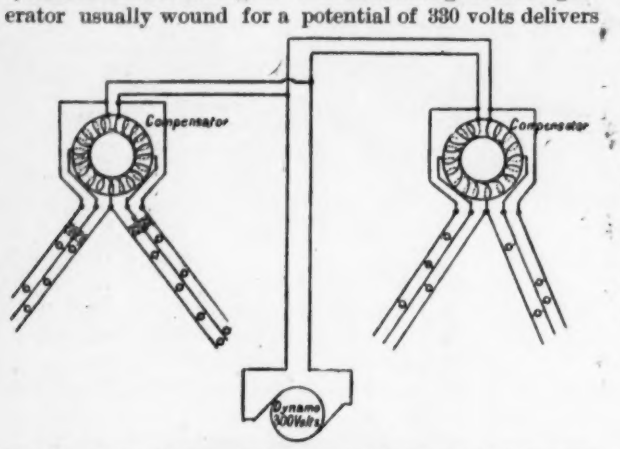


Fig. 5.—Prof. Elihu Thomson's "Compensator" System of Incandescent Lighting.

its current to the ordinary system of feeders and mains such as is employed in the direct two-wire system. At central points in the district to be lighted the compensators, or choking coils, are located—usually being placed upon poles at street intersections. A loss up to 10 per cent. of the dynamo potential, according to conditions, is allowed between the station and the lamps, and the pressure at the compensators is thus somewhat more than 300 volts.

The compensator consists of a laminated core of iron, as in a transformer, wound with a continuous insulated conductor, the terminals of which are connected directly to the dynamo leads.

At three points in this coil, dividing the coils equally between its terminals, wires are attached leading to binding posts on the compensator frame. The terminals of the coil are attached to similar binding posts, and from these five points are run lamp circuits, which may be two three-wire systems. The fall of potential through the compensator from one lead to the other will thus be divided into four equal parts, and the voltage in each lamp circuit will be, therefore, about 75 volts. It is evident that many variations may be made in this arrangement; the coil may be divided into any number of equal portions, and from them the circuits may be run on the 3, 4, 5, etc., wire systems, or the various circuits may be on the simple two-wire system. We take, however, this 330-volt two three-wire system to explain, as it was the one most used, and serves as well as any other to illustrate the principle of the arrangement.

Considering Fig. 6: There are at maximum load, say

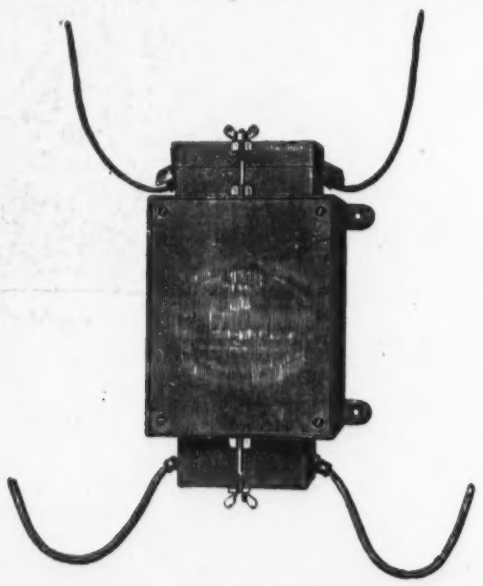


Fig. 8.—Thomson-Houston Transformer.

eight lamps on the compensator. When they are all turned on a very slight current traverses the coils of the compensators, the self-induction of its coils of wire wound about soft iron being so high as to practically prevent any current flow. Consider now that all the lamps on one of the three-wire circuits be turned off, the conditions are as in sketch 2, Fig. 6.

The current traversing the part of the coil "A" acts as the primary of a transformer, the secondary being the part "B;" transformation from 150 volts in the primary to 150 volts in the secondary thus takes place, and one-half the current in the lamp circuits is due to the dynamo current and one-half to that part of the compensator marked "B." The part "A" thus needs to carry only sufficient current for one lamp, and the regulating capacity of the compensator is seen to be four times the carrying capacity of its wire. If the lamps be arranged as in sketch No. 3 the first part of the compensator marked "A" will carry $\frac{2}{3} = 1\frac{1}{3}$ times the current required for one lamp. The ratio of conversion in this case being 1:3, the part of the compensator marked "B" will supply $\frac{1.5}{3} = .5$ times the current for one lamp.

In this way the action of the compensator for any arrangement of load may be readily deduced. In few words, its action is a combination of a transformer with a system of direct distribution.

The chief objection to this system is, of course, that it brings the high potential of the dynamo to the house wires. The compensators have been manufactured in two sizes, one for 75 and the other for 150 lights. These figures, however, do not denote the maximum number of lamps which may be operated from a transformer, but merely the amount for which the compensator will regulate, *i. e.*, the maximum allowable difference in the number of lamps connected to its circuits.

Transformer System.—The transformer system of the Thomson-Houston Electric Company is, like all other such successful systems, a constant potential one, the pressure employed being usually 1,000 volts. The dynamos are con-

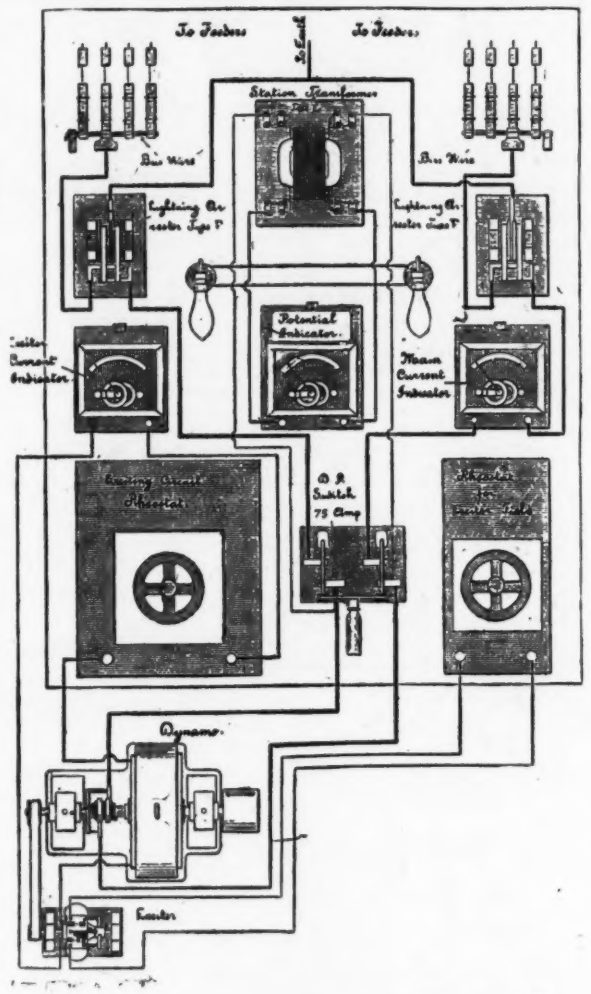


Fig. 7.—Switchboard for Thomson-Houston Transformer System.

structed to give 1,100, so that 10 per cent. may be allowed for loss in the primary and secondary circuits. As before stated, the dynamo is usually of the compound or "composite" type, the fields being excited by the rectified current from the alternator as well as by that from a small direct current dynamo.

In other respects this system is similar to other transformer systems and its principle needs no special explanation. Fig. 7 shows the form of switchboard employed. The various instruments which comprise it will be presently described. The dynamo has already been described. The standard type of alternator is the separately excited drum armature alternator, compounded to give constant pressure for a drop of a definite number of volts in the primary line between no load and full load. This alternator is excellently designed in all its parts, and between full and no load can maintain constant potential at the end of its primary line.

Transformers.—The latest form of transformer manufactured by the Thomson-Houston Electric Company is shown in its box in perspective in Fig. 8. The coils are enclosed in a cast iron box, waterproof, and stout enough to withstand ordinarily rough usage. The primary wires are seen coming out of the transformer at the top, and the secondary at the bottom, each passing through waterproof insulating bushings.

The coils are in some cases wound directly upon the cores, in others they are wound on wooden formers, which are removed when the coils are completed. In some forms the secondary winding is laid on first and the primary over it; in other forms the two are wound side by side. In either case the insulation between the two coils is very carefully made, consisting of mica, paper and shellac. The secondary coil is wound with two equal circuits, which may be either connected in series to give 104 volts or connected in multiple arc to give 52. Fig. 9 shows the switch device by which these connections are made and the fuse wire terminals for holding the safety cut-out for the secondary circuit

(To be continued.)

* From *The Electrician* (London), continued from The Electrical World, Dec. 27, 1890.

Some Experiments with Selenium Cells.

Mr. Shelford Bidwell recently presented a communication on the above subject to the Physical Society of London, of which the following abstract is given in the London *Electrician:*

Selenium exists in two allotropic forms, the one vitreous, as structureless as glass, closely resembling black sealing wax, and when in thin films is capable of transmitting ruby colored light; the other form is amorphous and exists as a red powder. If left for half an hour at a temperature of 200 degrees it becomes black. The amorphous variety is a non-conductor. The author observed that it was

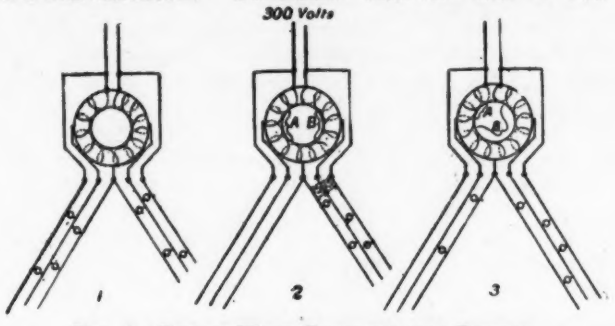


Fig. 6.—Three Wire Compensator System.

pretty generally stated in books that selenium in this condition was a good conductor, but this he had not found to be the case; for example, the specific resistance of one specimen, which had been carefully annealed, was as high as 2,500 megohms. When the annealing took place in contact with copper, the specific resistance fell to some 900,000 ohms, and he considered that the diminution of the resistance of selenium cells during the so-called annealing process was due, not to the effect of annealing, but to the formation of a conducting selenide of copper throughout the mass of selenium, beginning at the copper electrode.

The author observed that Willoughby Smith, in the year 1873, first discovered the variation in the resistance of crystalline selenium under the influence of light, and that the name selenium cell was due to Graham Bell. Graham Bell's photophone cells had a resistance of several megohms, and some ten years ago the author had suggested the following modification of Bell's cells in order to diminish this resistance. A strip of mica a few centimetres in length had copper wire wound over it from end to end, the distances between adjacent coils being about one-twentieth of an inch. The wire was wound in two parallel coils, the two coils being carefully prevented from touching each other at any point, and forming the positive and the negative electrode respectively.

Melted selenium was poured on to the strip, and pressed in between the wires. The cell was then kept for some time at a temperature of about 217 degrees, and the resistance was found to fall gradually to about 50,000 ohms.

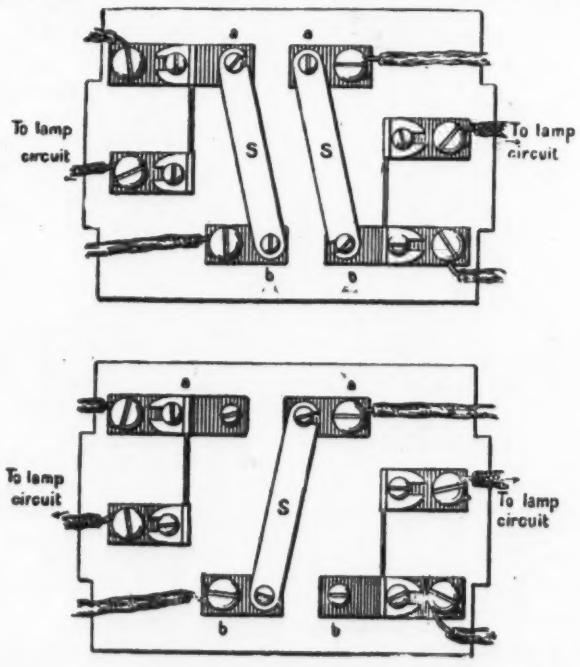


Fig. 9.—Connections on Thomson-Houston Transformer.

The author had made a number of these cells in the years 1880 and 1881, and had noticed that their sensitiveness to light gradually diminished, and in 1882 he laid aside a number of cells until 1885, when the greater number of them were found to be practically insensitive to light. He then (in 1885) laid aside 13 cells until the present year, and of these only one retained its sensitiveness. The resistance of this cell remained as high as 400,000 ohms, while the resistances of the others had all very greatly diminished. The resistance of another one was about 6,000 ohms. This cell was sensitive to light when employed in circuit with a single Leclanché cell; but with a number of cells the resistance broke down, falling to about 100 ohms, the cell at the same time becoming insensitive to light.

The resistances of the remaining 11 cells varied from 4 to 11 ohms, and they were all quite insensitive to the influence of light.

Professor W. G. Adams had found that the resistance of the selenium cells which he had constructed fell in the course of a year to about one-fortieth of their original

value, this fall being in all probability due to the formation of selenide of copper.

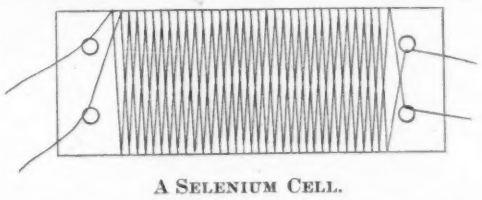
The author mentioned that the resistance of one of his own cells had fallen in the course of ten years from 80,000 ohms to 10 ohms. In a paper previously read before the society he had expressed the opinion that the presence of selenide of copper was necessary to the action of the cells, and that this was always formed during the so-called annealing process which was found to be essential to make the cells sensitive to the action of light.

It had occurred to him that the effect of passing a strong current through one of his selenium cells might be to liberate selenium more rapidly than it could combine with the copper anode, and to test this he had connected one of the cells with a 26-volt battery. The result of this experiment was the formation of moist red tufts, consisting mainly of amorphous selenium, all along the copper wire forming the anode. It was shown to consist of amorphous selenium, by turning black when warmed, and exhibiting the characteristic blue flame of selenium when burned.

The moistness of the tufts seemed greater than was to be expected, simply from the selenium being in the state of a fine powder. The red powder, when examined under the microscope, was found to be mixed with white lumps, which might consist of an oxide, or hydroxide of selenium. but he was not aware whether this was deliquescent.

In the discussion of the author's former paper the late Mr. J. W. Clark had objected to the hypothesis that the diminution of resistance was due to the electrolytic formation of selenide of copper; that in this case the selenide would only be found in the neighborhood of the anode; but the author considered that it spread from the anode until it extended to the cathode wire. The selenium cells, he pointed out, showed polarization effects, and developed an E. M. F. under the influence of light, forming photo-electric cells.

The author then exhibited some very striking experiments, to which he did not attach any serious importance, but which he thought were suitable for lecture demonstrations. The usual arrangement of indicating the presence



A SELENIUM CELL.

of an electric current by means of a galvanometer and a spot of light is convincing, but not impressive, and might often be replaced by a selenium cell with advantage. A selenium cell was connected up with a delicate relay and electric bell in such a manner that the diminution in the resistance of the cell on exposure to light diminished the current through the relay and caused the bell to stop ringing.

Different colored plates of glass were then interposed between the cell and the source of light—a gas burner—and red, orange and yellow glasses were found to exert no screening effect, but when a green glass was employed the light was screened off and the bell began to ring.

Two blue glasses were then tried, and the light blue was found to exert a screening effect, while a much darker blue did not. The reason of this, as shown by spectroscopic examination of the glasses, was that the dark blue glass, being colored with cobalt, allowed a good deal of red light to traverse it, but the red light was entirely cut off by the light blue glass. The author suggested that an arrangement of this kind might possibly be employed to ring a bell in case of the extinction of a ship's light or of a railway signal light, or to turn on electric light when daylight falls below a certain point; or apparatus arranged to ring a bell when the cell was exposed to light might be employed in a safe or strong room, and made sufficiently delicate to be thrown into action by the lighting of a burglar's lantern.

Resistance Coils and Boxes: Their Construction and Use.

BY CHARLES P. FREY, CHIEF ELECTRICIAN OF THE GREELEY ELECTRICAL LABORATORY.

IV.

The Electrical Balance or Reversible Bridge.—In every case when absolute accuracy is required in making measurements or duplicating a known standard, special precautions have to be observed to prevent any variation in the equilibrium of the apparatus used for the purpose.

For instance when a chemist wishes to determine the exact weight of any substance, he does not content himself with balancing it on one scale pan against a known weight in the other, but in addition tests the accuracy of his scale beam by interchanging the weights and material undergoing the process of weighing.

Now the previous articles on resistance measurement make it obvious that the correctness of results obtained by using any of the usual forms of Wheatstone's bridge depends mainly on the equality of the bridge coils employed. It is evident that if two coils, one on each arm of a bridge, are supposed to be equal to each other, and actually are not equal, perfect comparison between the standard and the resistance undergoing measurement cannot be readily obtained.

A very good method for detecting a discrepancy of this kind is to interchange the standard coil and the resistance being measured. But this operation, besides involving considerable trouble and delay, will serve only to make an error manifest, and other means must be resorted to in order to provide a remedy.

The apparatus illustrated by Fig. 15 is a form of electrical balance or reversible bridge, on which the positions of the two coils on the bridge can be reversed, and any change in either can not only be at once detected, but also provided for.

It consists (see Fig. 16) of a base of hard rubber mounted on corner blocks. Arranged thereon is a parallelogram

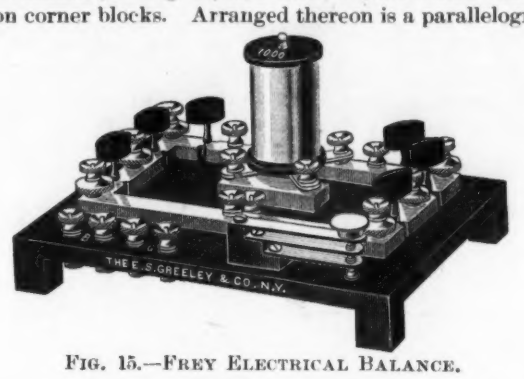


FIG. 15.—FREY ELECTRICAL BALANCE.

of brass, separated in places with plug connections, binding posts and bridge coils.

The shape of this parallelogram suggests the conventional diagram used to illustrate the principle of the parallelogram of forces as applied in describing the operation of Wheatstone's bridge. The meritorious features of this arrangement are simplicity and convenient construction. The method of using the balance is easily understood and the apparatus is not likely to get out of order. The construction and dimensions of the parallelogram preclude the possibility of any incorporate inequality in resistance.

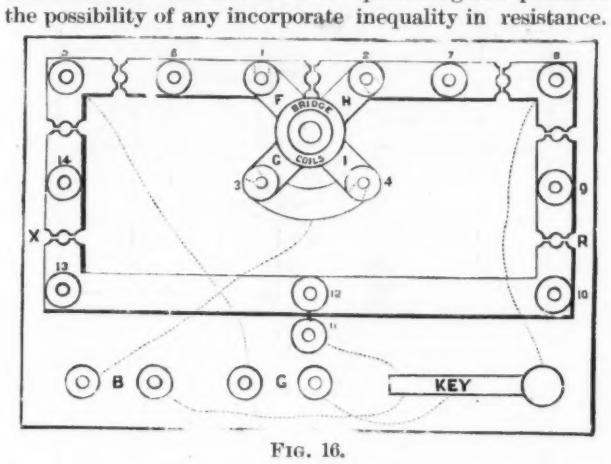


FIG. 16.

There are no soldered connections or invisible conductors, the resistance of which ordinarily forms an undesirable and uncertain factor.

The connecting wires under the base are outside of the parallelogram and if it will contribute toward the peace of mind of the experimenter may be removed and top connections to galvanometer, key and battery substituted. In fact the most arrant skeptic must admit that if he will only keep the plugs and contacts clean and bright, and the terminals of his standard coil and the mercury cups (if used) well amalgamated, there is positively no chance for error arising from insufficient contact. The battery wires are

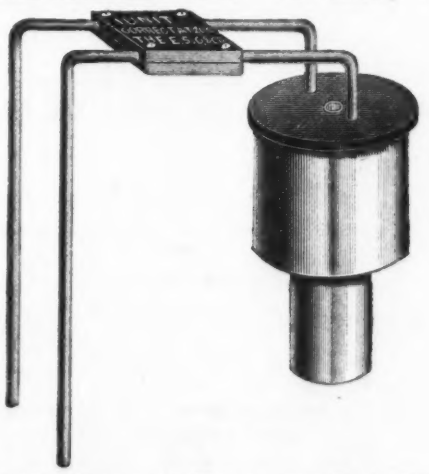


FIG. 17.—STANDARD COPY OF THE B. A. UNIT.

fastened at the binding posts marked *B*. The dotted lines show the path of the connections under the base. The brass segment on which are binding posts Nos. 3 and 4 is connected with one pole of the battery. The other pole is connected through the key with binding post No. 11, which in turn is connected with No. 12. The galvanometer wires are fastened at *G*, and connect through the key to Nos. 5 and 8. The terminals of a standard coil or box are secured at the binding posts 8 and 9 or 9 and 10, and the resistance to be measured at Nos. 5 and 14 or 13 and 14. The bridge coils are both wound upon the spool *E*, their respective terminals being connected to the copper strips *F*, *G*, *H* and *I*.

If a fixed instead of a variable resistance for comparison is desired, the best form for the purpose is a standard copy of the B. A. Unit, as issued by the committee, illustrated by Fig. 17. Probably the next best is a single standard Fig 18). Either of these coils should be immersed in water to within about one-half inch of the rubber top, and temperature noted by employing a chemical thermometer, graduated to tenths of a degree C.

If a B. A. pattern single coil is used as a standard, its terminal may be placed in mercury cups provided for the purpose at *X* and *R*. *R* and *X* are then compared in the usual manner. When an equilibrium has been established between *R* and *X* by reducing the resistance of the greater of the two, by means of a resistance box used as a shunt, the position of the two bridge coils is reversed by loosening the binding posts 1, 2, 3 and 4, and giving the coil box a half turn. The test is then repeated. If the galvanometer needle does not remain stationary, it is evident that the bridge coils are not equal to each other. To establish an equality the bridge coils must be readjusted, or the plugs between binding posts 5 and 6 and 7 and 8 are removed, and pieces of German silver wire or small coils are introduced. The resistance of these should be varied until the needle remains at zero.

The coils on the bridge spools may be corrected when out of adjustment either by leaving in position and balancing against two standard coils known to be equal, inserted at *R* and *X*, or by removing inaccurate coils and substituting another pair, and with the aid of an adjustable resistance at *R*, inserting the coils at *X* and adjusting in the usual manner. To permit the ready adjustment of these coils, their terminals are held by clamps instead of being permanently soldered. Although a clamp contact is generally a poor makeshift, in this instance its adoption is preferable. Attention is also called to the fact that bridge coils of low resistance have double shunt coils. One pair of wires is permanently soldered, and all adjustment must be made by moving the others, which are held by the jaws of the clamps. When low resistances are to be measured, the coil box is removed and a wire connected with binding posts 5 and 8, a graduated scale being placed under the wire, and

FIG. 18.—SINGLE STANDARD.

the circuit completed through a sliding contact connected with binding posts 3 or 4 by a wire connected to either.

A convenient contrivance for this purpose, which is readily attached, consists of a "wire bridge" half a metre in length, and provided with the usual sliding contact. Two heavy copper strips are furnished to connect with binding posts on the balance. This wire bridge may also be used together with the reversible coils if it is attached to binding posts Nos. 9 and 14. The standard coil and unknown resistance are then respectively connected with binding posts 8 and 9 on one side and 5 and 14 on the other. The connection between binding posts and 11 and 12 is removed and one end of a flexible conducting cord is attached to binding post No. 11, the other end being fastened to the sliding contact on the wire bridge. The resistance of the wire on the bridge must be carefully determined beforehand. Then when a difference in resistance not greater than the total resistance of the bridge wire exists between *R* and *X* this resistance can be determined without shunting either of these by moving the sliding contact and depressing *both keys at once*. If *X* should be greater than *R*, its value is determined by moving the sliding contact toward *X* (an operation which adds to the resistance of *R*) and frequently testing until a point is reached where equilibrium is secured. The value of *X* will then be *R* plus the difference in resistance of the two parts of the bridge wire at the point of contact. For instance—if the bridge wire has a resistance of one ohm, and $R = 100$ ohms, and the sliding contact stands 200 millimetres from *X*, then since it is necessarily 300 millimetres from *R*, a resistance equal to 300—200 millimetres of wire has been added to *R*. Now since the wire is one-half millimetre in length, the difference between 300 and 200 millimetres, or 100 millimetres of wire, has been added to *R*. Therefore $\frac{100}{500}$ or one-fifth of the total length, representing a resistance of one-fifth of one ohm, has been added to *R*, and *X* consequently equals 100.2 ohms.

In all measurements with this contrivance the actual resistance of the bridge coils is of no consequence, provided they are equal to each other and are each as nearly as possible equal to the resistance of the coil measured.

As both coils are constructed of the same size and quality of wire, and are upon the same spool, their change in resistance owing to variation in temperature will be identical.

Hence the only temperature correction necessary is between the standard and *X*.

It will be noted by referring to the diagram that the

battery connection with the lower side of the parallelogram is effected through an independent binding post (No. 11). This is usually connected directly with the binding post on the brass bar, No. 12. The resistance being measured when determined, can however be added to the standard resistance, and the two in series balanced against another resistance (introduced by connecting between binding posts Nos. 8 and 9 and removing the plug) by disconnecting binding post No. 12 from No. 11, after which one end of a flexible and well insulated conducting cord, the resistance of which is of no consequence, as it is outside of the parallelogram, is connected with binding post No. 11, and its other end is connected with binding post No. 9. In this manner any number of coils can be compared in absolute measure.

I have thought it of interest to members that tables and curves showing the effects produced in a particular case of varying the different quantities, t, V, and n, should be given, and I have therefore taken the following cases:

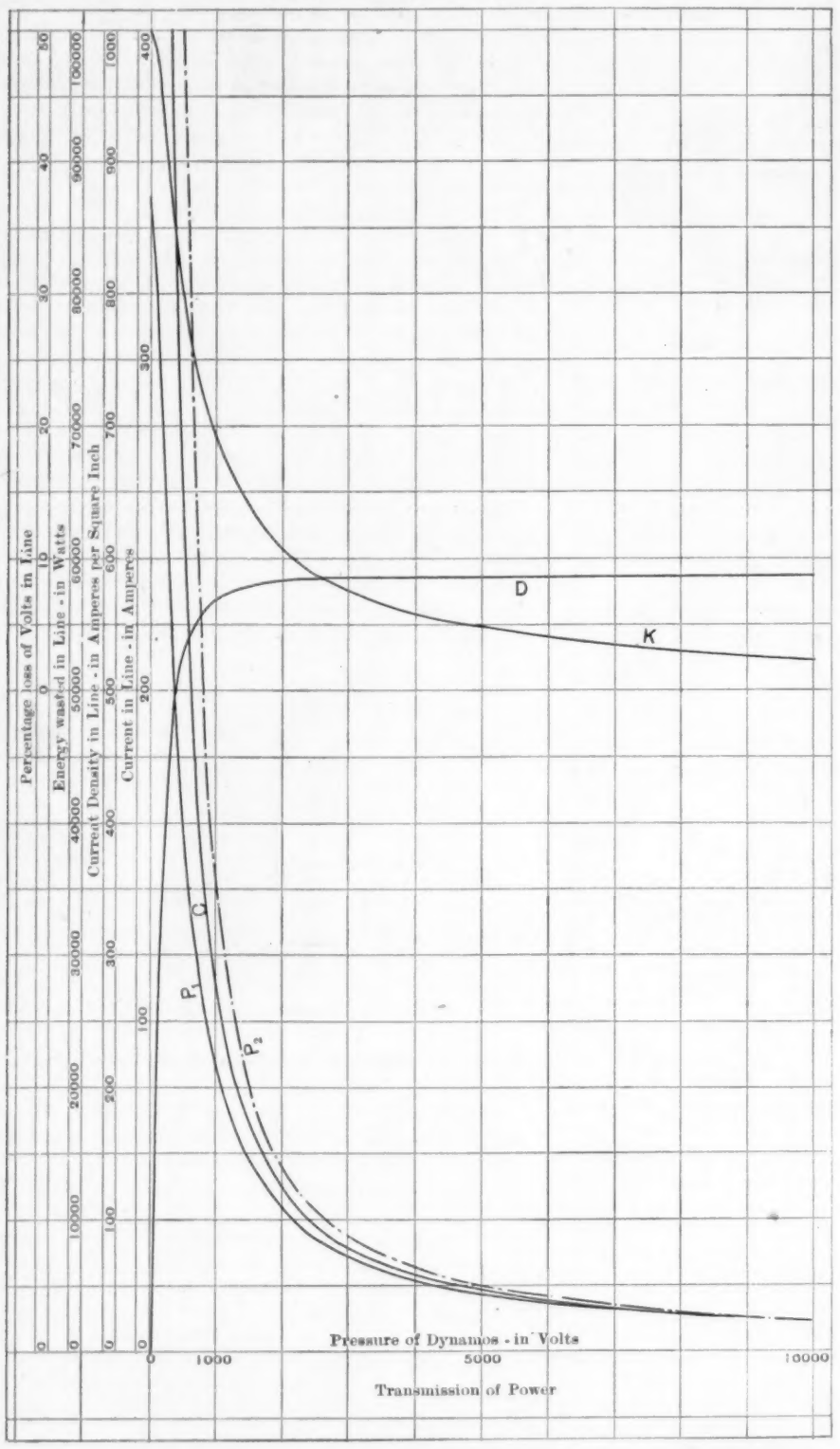
(i) $V = 2{,}000$ volts.
$n = 10$ miles.
t variable between 15 and 50.

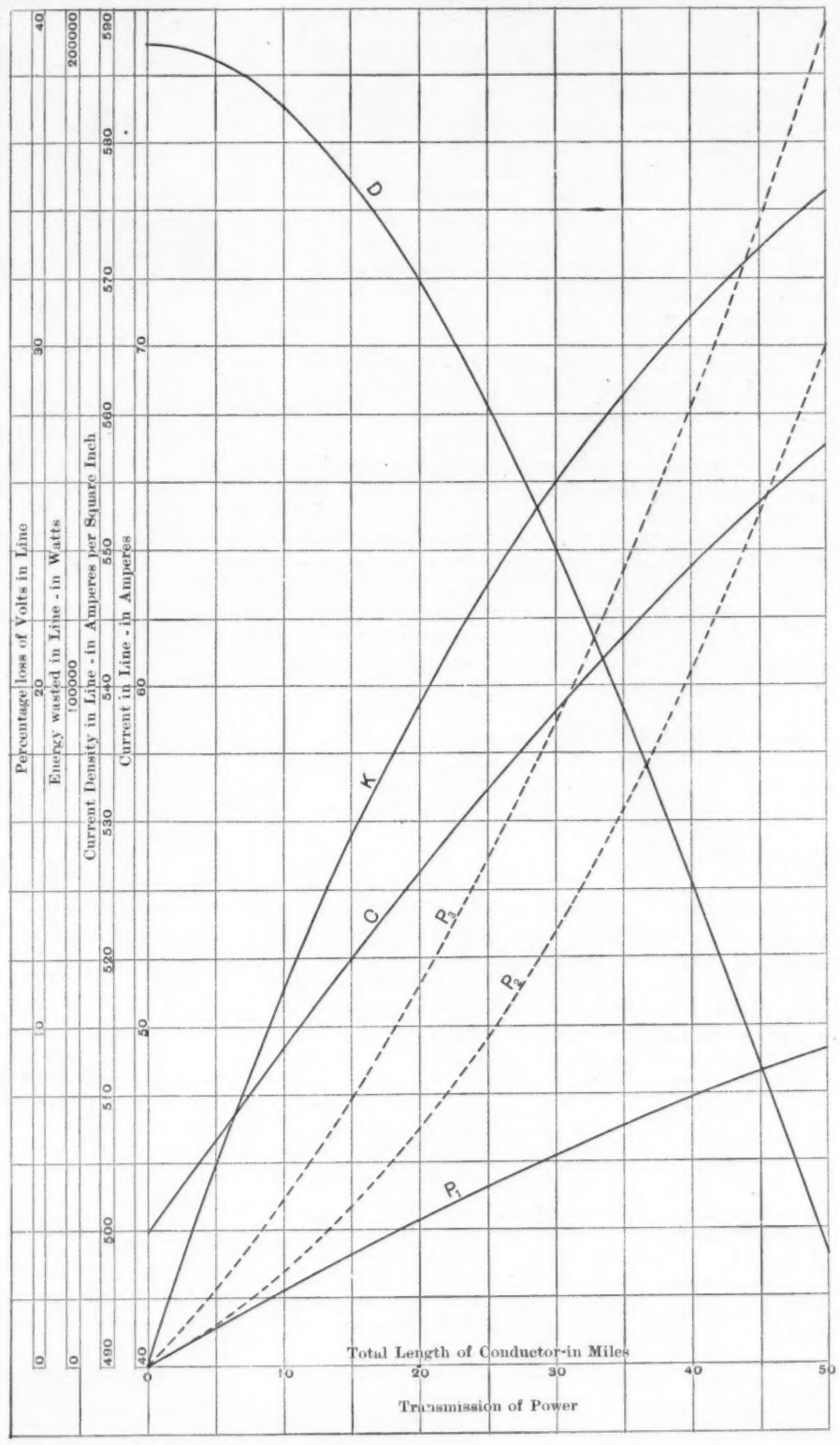
(ii) $n = 10$.
$t = 25$.
V variable between 500 volts and 10,000 volts.

(iii) $V = 2{,}000$ volts.
$t = 25$.
n variable between ¼ mile and 50 miles.

(ii) $n = 10$. $t = 25$.

V.	C.	D.	P_1.	P_2.	P_3.	K.
500	253.8	524 5	39,220	102,6‹1	141,901	30.9
750	153.9	556.6	27,732	53,386	81,118	24.0
1,000	109.0	569.4	21,270	34,892	56,162	19.5
1,500	68.08	579.1	14,418	20,091	34,509	14.1
2,000	49.29	582.7	10.878	13,958	24,836	11.0
3,000	31.66	585.3	7,283	8,602	15,885	7.7
4,0 :0	23.29	586.2	5,471	6,198	11,669	5.9
5,000	18.42	586.7	4,380	4,840	9,220	4.8
7,500	12.08	587.1	2,922	3,123	6,045	3.2
10,000	8.99	587.3	2,192	2,304	4,496	2.4





CURVES ACCOMPANYING MR. KILGOUR'S PAPER ON ECONOMY IN CONDUCTORS.

Notes on Economy in Conductors in Systems of Distribution of Electrical Energy.*

I have calculated the following table of values of $(1 + \sin \varphi)$ and $\left(\frac{\sin \varphi}{1 + \sin \varphi}\right)$ for values of $\tan \varphi$ between 0.025 and 4.0, thus embracing all practical cases, I believe. (See Table A.)

From this table, or from the curves given which have been constructed from it, it is a very easy matter to determine the proper current density to employ in any given case without any further calculation than that readily performed with a slide-rule.

With regard to t, its value is obtained from the equation

$$t = 93{\cdot}6\sqrt{\frac{L\,Q}{N\,U}},$$

where

L = cost in pence in copper in cable per pound.
N = number of hours of working per annum.
Q = sum of the rates of interest, depreciation and maintenance on capital laid out in cable,

and

U = cost in pence of a board of trade unit.

If L = cost in pounds sterling of copper in cable per ton, the equation becomes

$$t = 30.6\sqrt{\frac{L\,Q}{N\,U}}.$$

* A paper read before the Old Students' Association, by Hamilton Kilgour; continued from The Electrical World Dec. 27, 1890.

And lastly,

(iv) $V = 5{,}000$ volts.
$t = 25$.
n variable between one mile and 500 miles.

TRANSMISSION OF POWER.

(i) $P = 87{,}700$ watts. $V = 2{,}000$ volts. $n = 10$ miles.

t.	C.	D.	P_1.	P_2.	P_3.	K.
15	47.13	351.4	6,559	7,619	14,178	7.0
20	48.21	467.9	8,726	10,655	19,382	9.0
25	49.29	582.7	10,878	13,958	24,836	11.0
30	50.35	696.8	13,009	17,542	30,551	12 9
35	51.41	809.8	15,118	21,415	36,533	14.7
40	52.45	92¹.3	17,199	25,591	42,790	16.4
50	54.48	1,139	21,270	34,892	56,162	19.5

(iii) $V = 2{,}000$. $t = 25$.

n.	C.	D.	P_1.	P_2.	P_3.	K.
.25	43.99	587.2	274	276	550	0.3
.5	44.12	587.2	548	555	1,1o3	0.6
1.0	44.40	587.1	1,096	1,124	2,220	1.2
2.0	44.95	587.0	2,192	2,304	4,496	2.4
4.0	46.04	586.5	4,380	4.840	9,220	4.8
6.0	47.13	585.6	6,559	7,619	14,178	7.0
8 0	48.21	584.3	8,726	10,655	19,381	9.0
10.0	49.29	582.7	10,878	13,958	24,836	11.0
15.0	51.93	577.1	16,162	23,465	39,627	15.6
20.0	54.48	569.7	21,270	34,892	56,162	19.5
25.0	56.93	560.5	26,158	48,397	74,555	23.0
30.0	59.25	549.9	30,794	70,306	101,100	26.0
35.0	61.43	538.0	35,152	82,181	117,333	28.6
40.0	63.46	525.3	39,220	102,680	141,900	30.9
45.0	65.35	511.9	42,996	125,700	168,700	32.8
50.0	67.09	498.0	46,481	151,310	197,790	34.6

TABLE A.—Transmission of Power.

$\tan \varphi$	$1 + \sin \varphi$	$\frac{\sin \varphi}{1 + \sin \varphi}$	$\tan \varphi$	$1 + \sin \varphi$	$\frac{\sin \varphi}{1 + \sin \varphi}$	$\tan \varphi$	$1 + \sin \varphi$	$\frac{\sin \varphi}{1 + \sin \varphi}$
0	1.0000	0.0000	0.6	1.5145	0.3397	1.8	1.8742	0.4664
0.025	1.0250	0.0244	0.7	1.5734	0.3644	1.9	1.8849	0.4695
0.05	1.0499	0.0471	0.8	1.6246	0.3845	2.0	1.8945	0.4721
0.075	1.0748	0.0696	0.9	1.6689	0.4008	2.2	1.9104	0.4765
0.1	1.0995	0.0905	1.0	1.7072	0.4143	2.4	1.9231	0.4800
0.15	1.1482	0.1291	1.1	1.7402	0.4254	2.6	1.9333	0.4828
0.2	1.1961	0.1640	1.2	1.7680	0.4344	2.8	1.9417	0.4850
0.25	1.2425	0.1952	1.3	1.7924	0.4421	3.0	1.9487	0.4868
0.3	1.2874	0.2232	1.4	1.8137	0.4486	3.3	1.9570	0.4888
0.35	1.3303	0.2483	1.5	1.8319	0.4541	3.6	1.9635	0.4907
0.4	1.3713	0.2708	1.6	1.8482	0.4589	4.0	1.9701	0.4924
0.5	1.4472	0.3090	1.7	1.8619	0.4629	∞	2.0000	0.5000

(iv) $V = 5{,}000$. $t = 25$.

n.	C.	D.	P_1.	P_2.	P_3.	K.
1	17.63	587.4	439	443	881	0.5
2	17.72	587.4	877	895	1,772	1.0
5	17.98	587.2	2,192	2,304	4,496	2.4
10	18.42	587.6	4,380	4,840	9,220	3.7
20	19.29	584.5	8,727	10,655	19,382	9.1
50	21.79	569.8	21,270	34,892	56,162	19.5
100	25.38	525.4	39,220	102,681	141,901	30.9
150	28.06	469.9	52,620	210,480	263,100	37.5
200	29.94	415.4	62,013	361,430	423,440	41.5
250	31.24	467.0	68,481	556,550	625,030	43.9
300	32.13	325.8	72,970	795,990	868,960	45.4
350	32.77	291.4	76,140	1,079,700	1,155,800	46.5
400	33.23	262.7	78,440	1,407,600	1,486,000	47.2
450	33.57	238.6	80,140	1,779,500	1,859,700	47.8
500	33.83	218.2	81,426	2,195,500	2,276,900	48.2

In each case the power to be transmitted, P, has been taken as 87,700 watts, which, with motors of 85 per cent. efficiency, will give 100 brake h. p.

The accompanying curves and tables show what changes are produced in the different quantities tabulated —the most economical current density being employed in each case. I should mention that in the curves and tables are included P_1, P_2, P_3 and K where

P_1 = waste of energy in conductor.

P_2 = interest, depreciation, etc., on capital laid out in cable.

$P_3 = P_1 + P_2$.

K = percentage loss of volts in transmission of the power in each case.

You will notice that in cases of transmission of power over a considerable distance, P_1, the power wasted, bears a pretty high ratio to P, the power transmitted, so that the power of the generators must be considerably in excess of that actually required by the motors.

Now the value of U, and hence of t, depends to a certain extend upon the power of the generators $(P + P_1)$, and it is not difficult to see that this relation can be expressed by the equation

$$t = \sqrt{\frac{P + P_1}{A + B P_1}},$$

where A and B are constants depending on the conditions of the case under consideration. However, from these tables it is easy to judge approximately beforehand what P_1 will be in any given case, so that $P + P_1$ being known, t can be then accurately estimated, and C and D obtained as before.

To take an example, let us suppose that we want to transmit 100 brake h. p. from a waterfall to a mill at a distance of five miles. We will suppose that there is an effective head of 37 feet, that the efficiency of the motors is 85 per cent., that the loss in the line is about 15 per cent., that the generators have an efficiency of 87 per cent., that there is a loss of five per cent. in belting, and that we take 2,000 volts as our working pressure.

The power to be transmitted to motors will be 87,700 watts, that developed by the generators 110,000 watts, and that given by turbines 164 brake h. p.

For the water engines I shall suppose that we use 15-in. Victor turbines, of which the cost, and also that of the accessories, etc., has been kindly furnished me by Mr. Nell, and for the dynamos (motors and generators) I shall take the costs of Victoria machines in this example.

For the case we are considering, then, I estimate the cost as under:

Machinery and line (including posts, insulators, etc., but no cable)	£2,500
Buildings, foundations, pipes, etc	870
Labor (including running of cable)	750
Sundries	180
Total	£4,300

Taking then

17½ per cent. on £2,500	£437	10	0
12½ " " £870	108	15	0
7½ " " £750	56	5	0
10 " " £180	18	0	0
Total	£620	10	0
Cost of running machinery at both ends, and sundries (say)	£150		

The total annual expenditure in the production of 110,000 watts is therefore £770 for 2,808 hours (54 hours per week) per annum, or $U = 0.6$d.; hence $t = 26.7$ very approximately if we assume use of bare wire and take copper at 9¼d. per pound, and interest, depreciation, etc., on cable at 15 per cent.

Then, since $t = 26.7$, $V = 2{,}000$, $n = 10$, $\tan \varphi = 0.1335$, and $C = 49.6$ amperes, $D = 547$ amperes per square inch.

The necessary conductor would weigh about 10,120 pounds per mile, and cost £390 per mile. In it the loss of power would be about 12 per cent., so that we rather overestimated it when taking this at 15 per cent.

The following general notes on conductors may be of some use:

Of cables of the same class of insulation, and the same insulation resistance per mile, and the same cross-sectional area, a single wire is the cheapest, and the fewer the number of wires in a strand the cheaper is the cable. For example, take Silvertown class S, in which the single wires are about 18 per cent cheaper than the stranded cables of equal cross-sectional area.

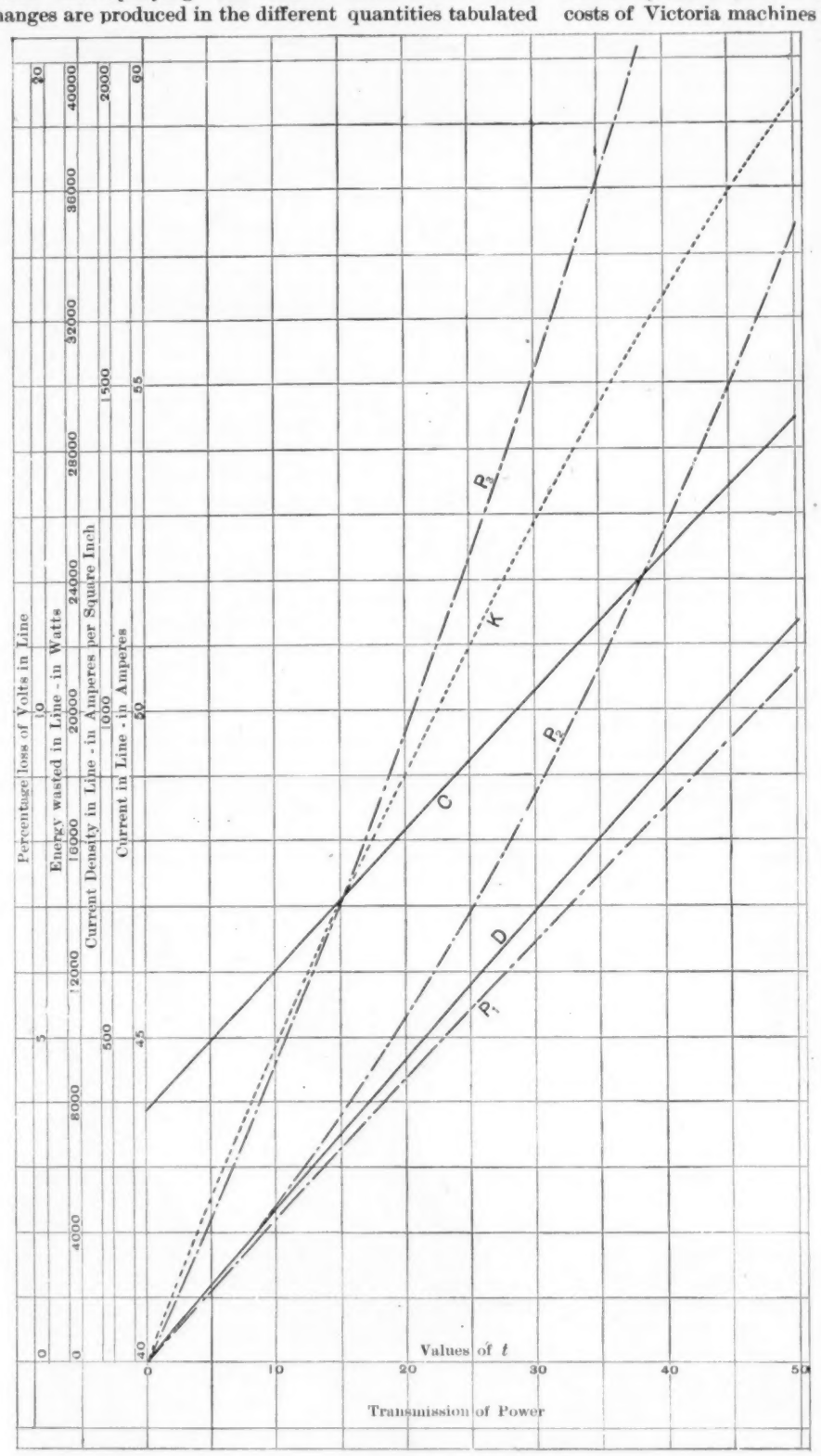
A concentric cable is generally, as you would expect, considerably dearer than two separate conductors with the same class of insulation and the same insulation resistance per mile between the going and return conductor.

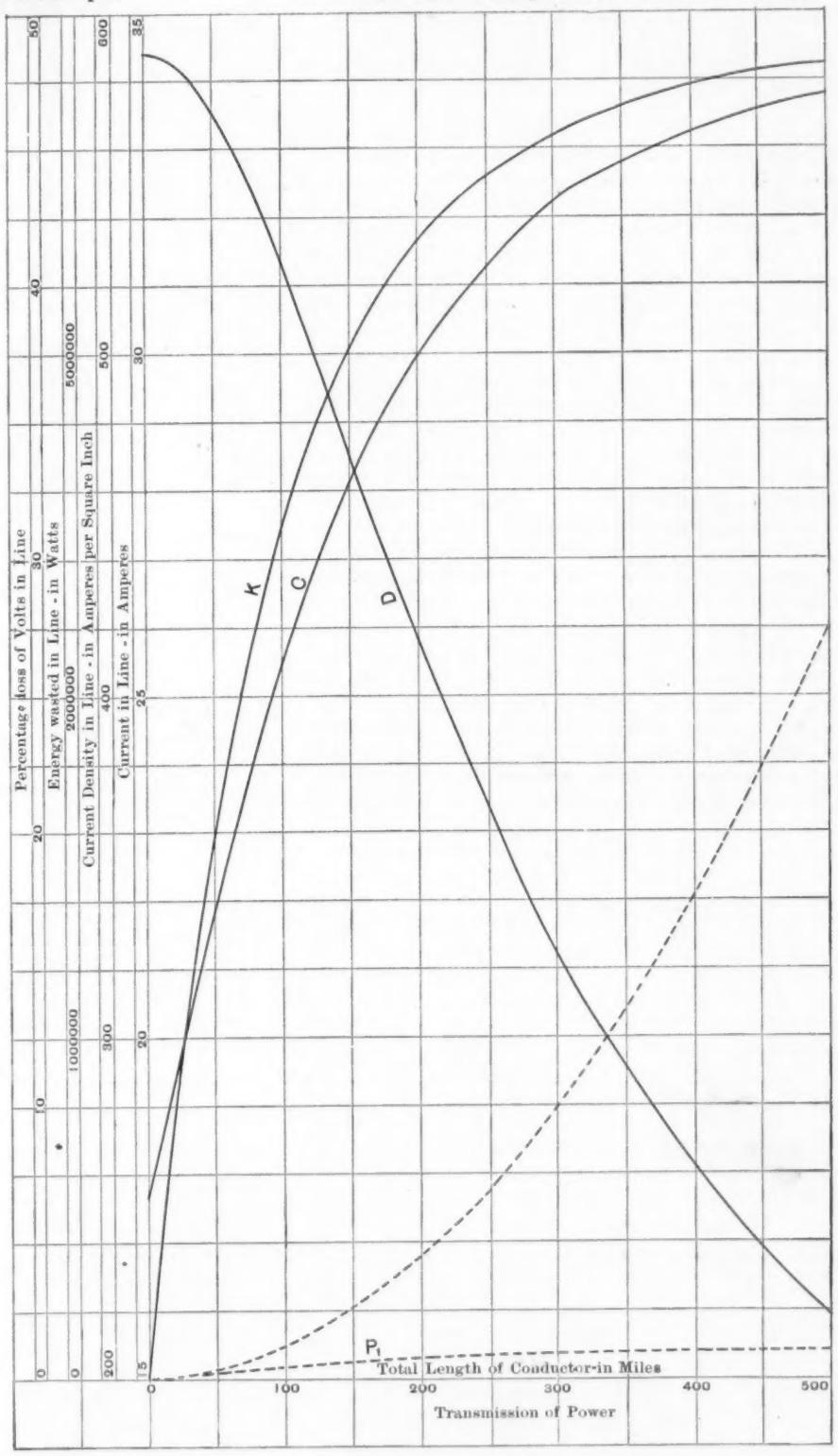
A cylinder of copper of one square inch area and one mile long weighs 20,400 pounds, or 9.1 tons very approximately, and it has a resistance of 0.0425 ω per mile at 60 degrees Fahr.

Such a cylinder 100 yards long weighs 1,160 pounds, or 0.52 tons, and has a resistance of 0.0024 ω per mile approximately.

These values apply equally to stranded cables with a high degree of approximation.

With stranded cables the effective area of cross-section and the weight per mile are about 2½ per cent. to 3 per cent. greater, and the resistance per mile is 2½ per cent. to 3 per cent. less than that of a cable composed of the same number of parallel wires.



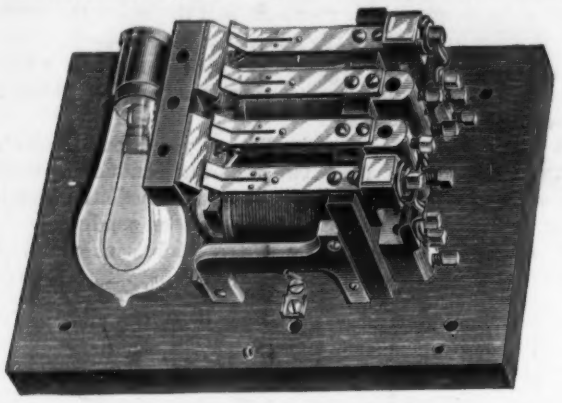

Percentage loss of Volts in Line
Energy wasted in Line - in Watts
Current Density in Line - in Amperes per Square Inch
Current in Line - in Amperes
K
C
D
P1
Total Length of Conductor-in Miles
Transmission of Power

CURVES ACCOMPANYING MR. KILGOUR'S PAPER ON ECONOMY IN CONDUCTORS.

The Bergmann Switch.

The Bergmann switch, which is shown in the accompanying illustrations, is designed for use wherever it is necessary to operate an electric switch at a distance without carrying the main wires to the point of contact. As will be seen, the switch consists of one pair of electromagnets, an incandescent lamp for resistance, and the switch proper. Two push buttons are necessary to operate it, one for lighting or closing the circuit, the other to extinguish or open

the circuit. When the closing button is touched it completes a circuit through the electromagnets and closes the switch; when the button is released a circuit is established through the lamp and magnets of sufficien' strength to retain the armature closed. By touching the opening button the magnets are short circuited, allowing the armature to fall away at the same time the lamp connection is broken, as shown in the diagram. Any number of push buttons may

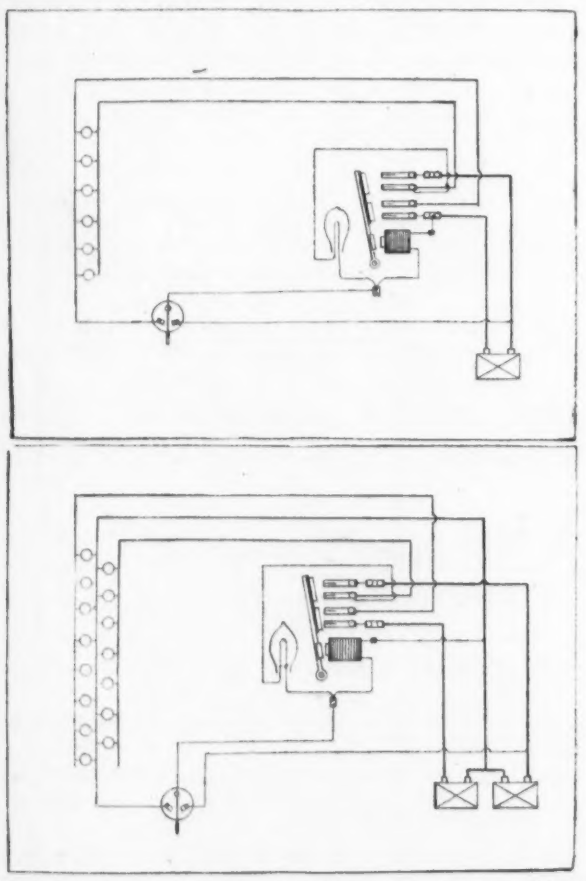


Bergmann Automatic Switch.

be attached to the same switch so that any circuit may be controlled from as many points as desired.

The current used to operate the switch is about one-tenth of one ampère, so a very thin wire will carry the current to the push buttons. In a house installation every circuit may be controlled with a few neat push buttons in the hall-way where unsightly hand switches would not be tolerated. The switch can be utilized for a great variety of purposes, for many of which it would be impossible or too costly to apply the ordinary hand switch. In running electric elevators, the operator when this switch is used merely handles a small lever or controls his car with two push buttons. Motors for any purpose may be controlled from any point desired. In ordinary house lighting every floor can be controlled from each floor. For instance, if three floors were to be controlled it would only be necessary to run three thin wires from top to bottom connecting respectively with switches Nos. 1, 2, and 3. With three push buttons on each floor every switch can be operated from any floor. This switch is manufactured by the Bergmann Electric and Gas Fixture Company of this city.

In buildings where the current is generated locally each floor or circuit can be operated from the dynamo room with push buttons and thin wires connected to the switch. The main or lighting circuit consists in this case of one pair of mains running the entire length of the circuit, with a switch at each branch, thereby saving the cost of running separate wires from the dynamo room to each circuit as is

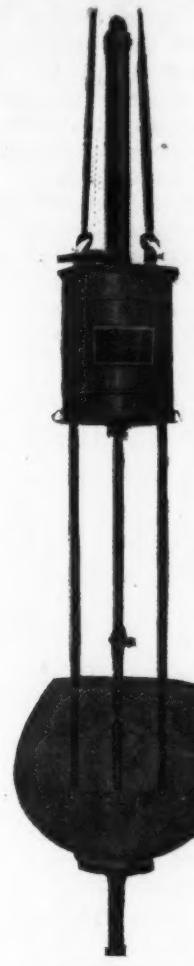


Connections of Switch on Two and Three Wire Systems.

now often done. For store or office lighting the switch can be operated by a clock so as to connect the lights at a certain hour and also disconnect them at any desired time.

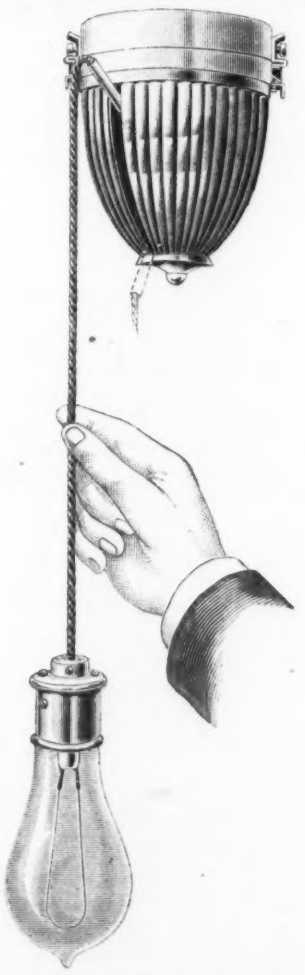
The Graves Arc Lamp.

In order to provide means in a duplex arc lamp for the successive burning of a second set of carbons after the first pair has been consumed, Mr. William D. Graves, of Cleveland, O., has produced the lamp illustrated on this page. The two sets of carbons have independent holders, consisting of rods of the usual kind connected with respective feed and holding devices. These consist of levers in the form of frames, through which the carbon-holders pass, containing a train of gear wheels and a brake wheel, by which the feed of the carbons is regulated. The frames are trunnioned between posts in the framework which supports all the mechanism. Friction wheels are provided to check the feeding of the carbon-holders. To the middle points of the two cores of the series and shunt coils of the regulating mechanism are attached the ends of the levers that operate the feeding



Graves Arc Lamp.

apparatus. At the opposite end of the lever is an arm extending downwards in such a way that any excessive movement of the solenoid core, such as would occur when the carbon held by that arm was consumed, brings it against a contact point provided for the purpose, and this acts as a switch to cut into circuit the second pair of carbons. This constitutes the distinctive feature of the lamp,



A Combined Lamp Pendant and Switch.

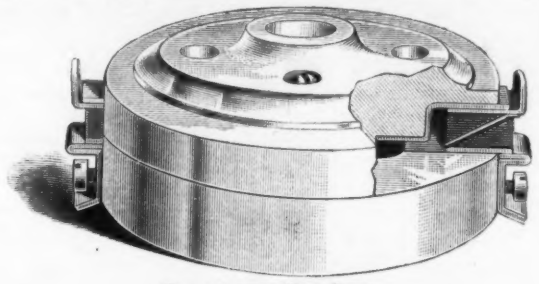
and it is evident that by the same method a triplex or quadruplex lamp may be constructed to burn in succession three or four pairs of carbons.

A Ceiling Pendant and Switch.

The accompanying cut shows one of the minor conveniences in electric illumination which has just been introduced by the Bergmann Electric and Gas Fixture Company of this city. It is an electric drop-light fitted with a ceiling switch instead of a key socket. The flexible cord is fastened at the upper end to a switch handle which moves on the slightest pressure. A single pull lights the lamp and the second extinguishes it, and so on. For some reasons it is an advantage not to have the frail, flexible cord constantly charged, and the present device gets around this difficulty very neatly and simply. The switch is of ornamental design, so that it presents an attractive appearance when placed on the ceiling, and the lamp, of course, can be swung in any position desired without interfering with the working of the apparatus.

A Convenient Cut-Out.

Of making cut-outs there is no end. It sometimes seems as though the ingenuity of inventors would never cease devising new and strange and unusual forms of this very simple bit of apparatus. Of the many which have recently

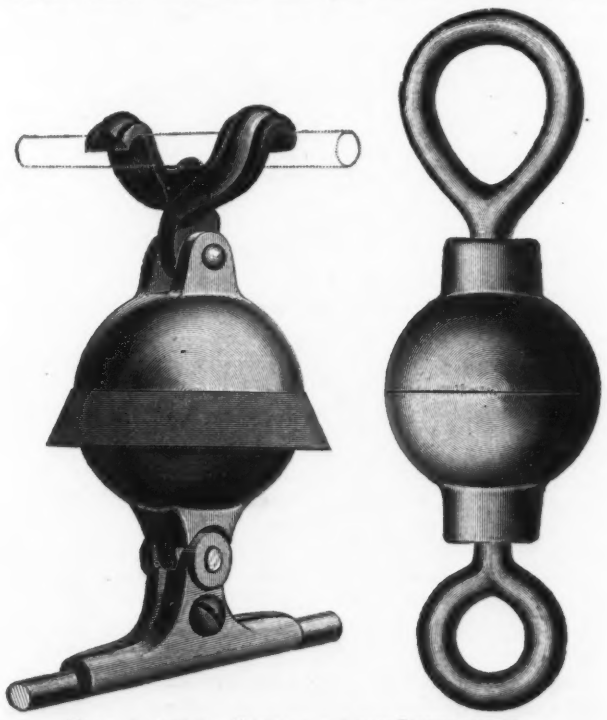


Bergmann Cut-Out.

appeared we know of no one that possesses more striking claims to ingenuity than the Bergmann cut-out, herewith illustrated. It is manufactured by the Bergmann Electric and Gas Fixture Company, of this city. Its peculiarity is evident on the most casual inspection; aside from the fusible wire being under the cap of the cut-out, which must be removed in order to replace the fuse, a much simpler arrangement is employed. The fusible wire rests in a slot in a non-combustible block. This block s provided with spring contacts and is pushed into a considerable aperture in the side of the cut-out box, with which it is nearly flush when in position. As a result, in this device, if for any reason the fuse blows out, the block can be slipped out and replaced in a moment without taking down the lamp, or opening the cut-out box. The ease of access and of replacing the fuse is no small convenience, and the simplicity of the whole arrangement is very striking. It is one of the neatest minor accessories that has appeared on the market for some time.

Street Railway Line Accessories.

There have been many attempts made to solve the problem of combining great strength with lightness, neatness in design and the high insulation required by street railway service in the manufacture of trolley wire hangers, centre curve insulators and pull-off brackets. Several



Figs. 1 and 2.—Railway Line Insulators.

novel ideas have been introduced in the design of the appliances mentioned by Mr. Chas. Robinson, who has lately identified himself with the Electrical Construction and Repair Company, of Chicago.

The trolley line hanger shown in Fig. 1 introduces an entirely new type, and seems to possess some points of merit. The span wire clamp is of brass and can be made to clasp the span wire with sufficient lightness to prevent any slipping or side movement. The globe part is of cast iron, the two halves being separated by about one-half inch of hard rubber extending beyond the edge and so shaped as to make an umbrella-like watershed. It will be seen also that the clamp holding the trolley wire is set up by a screw, and also that it leaves the under part of the wire exposed.

The centre curve insulator (Fig. 2) is chiefly composed of cast iron, the insulation being effected by the introduction of hard rubber bushings of ample extent and thickness to prevent leakage. The chief objection to some of the old styles of curve insulator was the lack of sufficient strength to hold a heavy line, especially in winter, when the strain

is greatly increased, owing to the contraction of the line, and sometimes by the added weight of ice.

The pull-off bracket is essentially a combination of the line and curve insulators, and presents nothing that is not embodied in the other devices.

A Resume of the Experiments on Electrical Undulations of Professor Hertz.*

I undertake a brief survey of the recent and most important experiments in electrical undulations, carried out first by Professor Hertz in Germany, initiated almost at the same time by Lodge in England, and repeated by Touton and Fitzgerald also in England, by Egeroff in Russia, by Joubert and De Nerville in France (who had the advantage of assisting at the Laboratoire Central d'Electricité in Paris), and in a reunion of the Congress of Electricians held on the occasion of the Paris Exposition of last year.

Faraday said that it was allowable to admit that the transmission of electrical energy might be effected by means of the ether, because it was probable that if this ether existed, it could fill another office besides serving as a medium for the propagation of light. Maxwell was also led to conclude that electrical action was transmitted through space by means of oscillations of the same order as the luminous waves, the difference between the two manifestations depending only on the difference in the length of the waves.

To verify this doubt which existed in the minds of scientists a direct experiment was required, and this has constituted the object of the experiments carried out by Prof. Hertz in 1888-89.

These researches form an important step towards the understanding of the nature of electricity, and of the connections which bind it to another of the physical agents, because they demonstrate to us—

1. That the medium which intervenes in the electrical phenomena is the same as that which is the seat of luminous phenomena.

2. That the perturbations of the two species are propagated under the same conditions and with equal velocity.

3. That there exists an identity of nature between certain electrical and luminous phenomena.

Besides, since one of the greatest triumphs of Dr. Hertz consists in having realized an arrangement by which the length of the electric wave is considerably reduced this opens up a great hope for the industrial production of the electric light. In fact, the different sources of light can be compared amongst themselves by methods different from the ordinary photometric ones. We can, for example, inclose the lamps to be experimented on in an opaque calorimeter, which admits of measuring the energy expended in the total radiations W, and also in a transparent calorimeter which allows the luminous radiations to pass. The energy consumed by these will be measured by the difference between the two results, W and W_1, and the relation

$$\frac{W-W_1}{W} = \frac{\text{luminous radiations}}{\text{radiations total}}$$

will serve to estimate the luminous results. The experiments have given the following :

Light.	Candle.	Petroleum lamp.	Gas lamp.	Oil lamp.	Electric lamp.	
					Incandescent	Arc.
Luminous Result.	0.00293	0.00315	0.0317	0.00442	0.06	0.1

Now, although the cost of the electric energy and the necessity for expensive and complicated apparatus, reduce the apparent advantages, it is still allowable to forecast a considerable progress in the industrial production of the electric light. In fact, in an arc lamp, which, by the above figures, secures to us the greatest yield of light, nine-tenths of the energy expended are lost, because consumed in the production of invisible radiations. But the researches of Dr. Hertz lead us to hope that we may succeed in obtaining radiations of a determined period, and if so we shall be able by this means to transform the whole of the energy expended in luminous energy, and then the cost of electrical energy will be of no importance relatively to the result obtained.

In order to prove that the propagation of electricity enters into the category of undulatory movements, it is necessary to turn to periodical phenomena; and in this we may observe that electro-statical and electro-dynamical phenomena only rarely present this character. Alternating currents are produced with a certain period, but with the means by which we obtain them from the machines the number of alternations per second is too small to reduce the length of the wave to a manageable size. In fact, if we admit the velocity of propagation of the electrical action to be that of light, that is, 3,000,000 kilometers (3×10^{10} G. C. S.), per second, the length of the wave expressed by $C = \frac{3 \times 10^{10}}{n}$ if n is the number of alternate currents which succeed each other in the same period of time.

In order to produce the alternations with sufficient rapidity, it is necessary to have recourse to the two following means :

1. Let there be a condenser with capacity C possessing an initial charge Q_0 and discharging it through a circuit of residual capacity R and with a coefficient of auto-induction h (see Note 1; also Fig. 1).

The current of discharge is

$$i = -\frac{dQ}{dt},$$

and in virtue of Ohm's law, taking account of the auto-induction in the circuit of discharge,

$$i = -\frac{dQ}{dt} = \frac{V - L\frac{d.}{dt}}{R},$$

V being the difference of potential. Under another form as

$$i = \frac{\frac{Q}{c} - L\frac{di}{dt}}{R}$$

and

$$\frac{di}{dt} = -\frac{d^2Q}{dt^2},$$

transposing we obtain the general equation characterizing the discharge,

$$\frac{d^2Q}{dt^2} + \frac{R\,dQ}{L\,dt} + \frac{Q}{CL} = O \qquad (x)$$

(See Note 2.

This equation has other solutions according to the value of $\frac{R}{L}$ and of $\frac{Q}{CL}$.

If the resistance of the circuit is inferior to the critical value

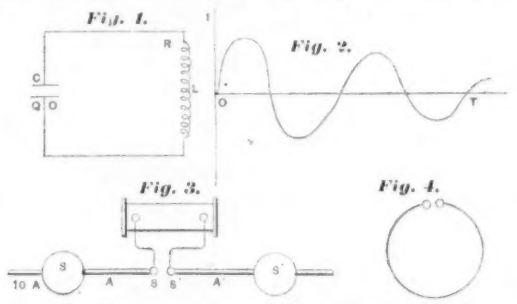
$$R_0 = \sqrt{\frac{4L}{C}},$$

the current of discharge will be periodical : its intensity being expressed by the formula

$$i = e^{-\frac{R}{2L}t}\, Q_0 \frac{\frac{1}{CL}}{\sqrt{\frac{1}{CL} - \frac{R^2}{4L}}} \sin \sqrt{\frac{1}{CL} - \frac{R^2}{4L}}\, t,$$

This expression—which becomes O for $t = \infty$—demonstrates that the intensity is represented in the case treated of by sinusoids of superior order.

The equation which gives the value of i allows us to



FIGS. 1 TO 4.—EXPERIMENTS ON ELECTRICAL UNDULATIONS.

calculate the period of the current, which, considering the return in the same sense, is expressed by

$$T = \frac{2\pi}{\sqrt{\frac{1}{CL} - \frac{R^2}{4L}}}$$

and in the case, when the resistance can be neglected,

$$T = 2\pi\sqrt{CL}$$

Many experiments have demonstrated the reality of this fact, studied first by Helmholtz, compared and analyzed by Thomson, and proved in 1888 by Hertz. Reflecting the spark which passes on the interruption of the circuit of small resistance on a system of mirrors rotating with a very rapid and uniform movement, we distinguish a series of luminous points, and the discharge is called oscillating. In order to have the discharge continuous, it is necessary that the resistance of the circuit be relatively considerable; but still, if L, that is, the auto-induction, is large, it may have the oscillating form. We can give a simple idea of the phenomenon in question by means of an analogous fact, which may be produced with liquids.

Let us imagine two reservoirs separated by an elastic partition and containing a liquid maintained at a different pressure in each. Evidently the partition will be curved towards the chamber where the pressure is least.

If now we unite the two reservoirs by means of a long and narrow tube, in other words, producing by the circulation an appreciable resistance of friction, the liquid will flow regularly toward the compartment where the pressure is least, and the containing partition will readjust itself without oscillation; on the contrary, if the two reservoirs are put in communication by means of a short and wide tube—therefore under the same points of view, with very slight resistance—a rapid movement of the liquid will take place, the elastic partition will pass beyond the position of equilibrium, so that the liquid will return in part to the chamber from which it was released and so forward and backward, each movement being accompanied with a gradually decreasing oscillation of the elastic wall. It is a similar case to that which is experienced in the discharge of a Leyden jar, in which the dielectric is in a state of tension (see Note 3), and if we discharge a condenser through an electro-magnet with a steel core, the coefficient of auto-induction being large enough, we produce the oscillating discharge. Under these conditions the effects of such a discharge are the magnetization of the steel core alternately in a contrary sense, which by degrees penetrates less deeply into the mass, so that by the action of an acid we can gradually destroy the outer strata of the core and show by means of a magnetic needle that the successive magnetizations have been inverse.

By the oscillating discharge the undulations obtained are comprised between 10,000 and 100,000 per second, and therefore, as a minimum, the length of the wave descends to three kilometres.

If we suppose that the extremity of the secondary circuit of a Ruhmkorff coil is connected to the armature of a condenser (or also not in contact), in correspondence with the interruptions in the primary circuit of the coil, the charges of contrary sign created by the act of the preceding closing of the two armatures, or the difference of potential developed at the extremity of the open secondary circuit, will have the effect to produce in this secondary circuit an inverse current to that which the change on the difference of potential had produced ; a current which will develop in its turn extra currents, so that also in this case the discharge will assume an undulatory character.

These undulations were studied by Thomson, by Kirchhoff, Helmholtz, Oettingen, Feddersen, Bernstein, Mouton, etc., and have a duration ordinarily of .0001 second.

By these two means obtaining a very rapid succession of alternating currents, Dr. Hertz has connected them in his arrangement, and with them obtained oscillations still more rapid, and of which the duration can be calculated in billionths of a second.

The exciter used by Dr. Hertz, being the combination of a condenser and an induction coil, was composed of two bars a and a' (Fig. 3), of five millimetres in diameter terminating at the further extremities in two large spheres, S and S', 30 centimetres in diameter, and at the inner end in two small spheres s and s' three centimetres in diameter, separated from each other about 0.75 centimetres ; the spheres S and S' stood at a distance of about one metre, and each armature of the condenser just described communicated permanently with the poles of a Ruhmkorff coil. In other experiments Hertz substituted for the two large spheres two square sheets of brass, 40 centimetres square, and this was done also by Joubert and De Nerville and Egeroff in their reproductions at the Laboratoire Central and at the Société Internationale des Electriciens.

In experiments still more recent Dr. Hertz made use of a cylinder of brass three centimetres in diameter and 26 centimetres long, divided in the middle; and this cylindrical exciter gave 10 times as great a number of oscillations as that with the spheres. Lodge employed, instead, a condenser of plates of glass and metallic sheets, and which he discharged in a circuit, of which the coefficient of auto-induction was also a centimetre. (See Note 4.)

In order to verify the production of the electrical undulations, and to analyze the properties of reflection, refraction, interference, etc., the arrangements required another apparatus, and for this end the illustrious Professor of Carlsruhe has availed himself of an artifice used in acoustics. As we know, the analysis of sound is accomplished in a manner which is physical and independent of the ear, by means of copper spheres (called resonators) of dimensions such that their vibrations produce a certain determined note, and they do not vibrate unless among various notes sounded there happens to be the note which is proper to themselves. We can also escape the necessity of verifying the sonorous vibrations by the ear when, with an arrangement analogous to the sensitive flame of König (see Note 5) we put the resonator in communication with a manometric capsule, which causes a flame to oscillate every time that the spheres sound, and the agitation of the flame can be brought into prominence and observed by a system of revolving mirrors.

In the same way Dr. Hertz makes use of a resonator (Fig. 4) composed of a metallic thread bent into a circular or square form, and the extremities of which are separated by a very small distance, and which can be regulated to great nicety by means of a micrometer. The dimension of this figure is shown to have an influence on the intensity of the phenomena observed, and this naturally depends on the necessity of using an apparatus in which the period of the electric movement is the same as that of the exciter, in order to have the greatest effects; for this reason the name resonator is given to the figure in question, because it acts on exactly the same principle on which the apparatus of the same name serves in acoustics.

Joubert and De Nerville use instead of this a rectilinear resonator formed of two pieces of copper wire (Fig. 5), the outer extremities of which are connected to sheets of tin to form a condenser, and at the extremities approach each other. One of the wires was rounded and the other pointed. Also in this arrangement a micrometer served to vary the distances of the ends; and the most convenient length of the wires and sizes of the two sheets was determined by experiment. Joubert proposed to render the phenomena visible, but could not obtain any satisfactory results.

Egeroff, on the other hand, fixed on the use of Geissler's tubes, and succeeded with only one of sixty in obtaining results sufficiently satisfying the wished-for conditions. This tube had been kept for fifteen years, and contained highly rarefied ammonia.

Before coming to the results of the various experiments we must say that practice has demonstrated how, in the production of rapid oscillations by means of the exciter

*From *Engineering*. Abstract of a paper contributed to *La Revista Maritima* by Giulio Bertolini.

just described, there exist complex influences, some fixed, others unknown and almost capricious; not only is the distance maintained between the two spheres important, the state of their surfaces and the dimensions of the induction coil, but also the light by which the apparatus is illuminated plays a varied and important part, also the hygrometrical condition of the atmosphere, etc. As an example, a bright violet light extinguished the oscillations completely, and another time—not in this condition of the light—simply blowing on the surface of the spheres was sufficient to cause the phenomena, which without any known reason could not previously be obtained.

As a settled arrangement in the experiments at which I had the pleasure to assist, the coil used was of a Carpentier model of 600 "lire" acting with a Marcel-Deprez interrupter, and with a current of 15 ampères, when the interruption in the secondary circuit was suppressed. Practically we judged of the satisfactory action of the apparatus by the aspect and sound of the spark; this should show a very fine, brilliant and straight track, and be accompanied by a dry crackling noise. So much premised, the exciter acting conveniently, and the resonator being well adjusted, we meet with sparks of 8 millimetres or 10 millimetres in the vicinity of the exciter, and these gradually decrease by augmenting the distances, still remaining visible at 15 or 20 metres. Further, the sparks are greatest when the plane of the resonator is parallel to the exciter, and cease to be produced when it is in the plane normal to it.

We recognize that we have to do with true electric rays (analogous to luminous rays in the sense that they are propagated in right lines, out of which their action is not perceptible), by the use of parabolic mirrors of large dimensions. These rays traverse insulating substances, and on the other hand are partially or totally reflected by conducting bodies, such as zinc plates, linen covered with tinfoil, or gilt paper, etc., and in reflection we can state that the angles of incidence and reflection are equal.

After the example of Dr. Hertz, we can also carry out the refraction experiment. For this the illustrious Viennese scientist used a large prism of asphalt, of which the faces were more than a square metre in area; the angle of incidence was 30 degrees. This prism being situated in the course of the electric rays, Hertz found that while the sparks were not produced at the resonator when it was in the direction of the incidental rays, they commenced to be produced by a deviation of 11 degrees, and reached a mamimum at 22 degrees, and he thus measured the index of refraction (see note 6) of the asphalt by means of the electric rays.

The influence of light on the production of the spark is demonstrated in a very evident manner by bringing the resonator very closely to the exciter, and burning magnesium in proximity to them. The aspect of the sparks from the exciter changes, and at the same time those from the resonator disappear. If now in these conditions we interpose a sheet of glass, the phenomenon is reproduced, whilst it is not re-established on interposing a sheet of quartz, which allows the violet rays to pass.

The existence of the electric wave can be put in evidence in an absolute manner by means of an experiment of interference, analogous to that used by Savart to show the interference of the direct sound waves with those reflected by a wall. For this end the partition opposite to the exciter is covered with a sheet of zinc; the waves reflected from it, interfering with those direct, show themselves by separate stationary waves with fixed nodes, and the position of these is shown by the cessation of sparks, which show themselves in them when we explore the interval between the exciter and the partition or screen with the resonator.

Determining then by means of the fixed nodes the length of the waves (and by the quality of the exciter, the length of the period being known), we can deduce the velocity of propagation of the electric action. In this way, by the method I have indicated, the velocity was found to have the value of 300,000 kilometres per second, which is equal to that of the propagation of light.

Hertz has also studied the propagation of the electric wave in an electric wire. For this he has placed parallel to one of the plates another similar sheet joined to a copper wire stretched horizontally in the plane symmetrical to the exciter (Fig. 6). Under these conditions the electric oscillations of A determine the corresponding oscillations of P, and these are transmitted to the wire. Exploring the course of the wire with the resonator in the same plane of symmetry with the exciter—so that it may be withdrawn completely from the direct action of the exciter, and influenced only by the current in the wire—Hertz has found that the sparks pass in a maximum, diminish and cease at many points, reappear, augment in length, and so on. This proves that in the transmission through the wire the oscillations were reflected at the extremity, giving rise to a series of nodes and loops at regular distances, and if the wire be cut at one of the nodes the phenomena remain the same, in full agreement with a known experiment in acoustics.

Dr. Hertz has availed himself also of his apparatus to demonstrate the retardation which occurs in the propagation of electrical action.

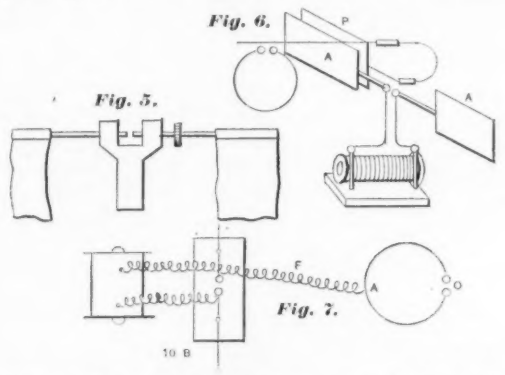
For this purpose he has adopted the arrangement represented in Fig. 7, and has thus been able to recognize that when A is at an equal distance from the extremities of the conductors no spark is produced between them, while brilliant sparking takes place when the point of attachment of the wire F is displaced a certain amount from the central point. In order that the experiment should be successful, it is necessary that the wire F should be long enough to escape almost entirely the distant action, transmitted to the secondary conductor across the space surrounding the wire.

The phenomena serve then to prove the retardation in the propagation, since the spark is produced by the creation of a difference of potential, which does not occur, but we have simultaneously at the extremities O, the same potential of the primary pole if the point A corresponds with the centre of the secondary conductor. The spark is produced if A is displaced, so that the two waves will arrive at the interruption with a difference of phase.

With this I conclude the series of experiments carried out by Professor Hertz without considering in what measure the theory of Maxwell adapts itself to the phenomena referred to, or what consequences are to be deduced from it; because in this domain of scientific research the introduction of electricity in the programme of this review must cease, it appears to me, with the work of signaling. Special publications can then furnish what is necessary to whoever wishes to study the arguments in detail; as for myself, filling the simple duties of signal officer, I shall feel much gratified if I have succeeded in having interested the intelligence of others in researches which are of such great importance.

As was stated at the commencement, the experiments which have been described show that electrical vibratory movements and luminous vibratory movements are propagated with the same velocity, corresponding to a modification of the same nature in the same medium, and they have influence the one on the other. The marked (notable) difference which we encounter in the results is in the duration of the period, since, in agreement with vibrations of a duration of a billionth of a second, we arrive at a maximum length of wave of 30 centimetres, whilst that of the longest visible rays—red is 0.5×10^{-4} or 60,000 times less.

This difference, though very great, as I have said, has not prevented Lodge from suggesting the possibility of producing the light without the intervention of heat, although



Figs. 5 to 7.—Experiments on Electrical Undulations.

—on account of the magnetic permeability of the medium and its specific inductive power—the hope may be called premature (see note 7). Meanwhile, in another order of facts, Carby, wishing to demonstrate experimentally (see note 8) recently how the induction between telephone wires is due rather to electrostatic than to electromagnetic action—inasmuch as the telephone waves are relatively large—has thought of the possibility of obtaining by means of the interposition of one or more bodies an interference or refraction producing the effect of preventing, through the above-mentioned means, the telephonic perturbations.

NOTES.

1. To sum up, we can say that the coefficient of autoinduction is only the coefficient of the term which corresponds to the external work in the creation of the electric field, and being homogeneous of one length, can be measured with the system C. G. S. in centimetres.

2. The general equation above indicated can be put under the form

$$\frac{d^2 Q}{d t^2} + 2 a \frac{d Q}{d t} + b^2 = 0,$$

As

$$a = \frac{R}{2 L},$$

$$b = \sqrt{\frac{1}{C L}}$$

resolving, we put

$$Q = A e^{m t}$$

$$\frac{d Q}{d t} = A m e^{m t}$$

$$\frac{d^2 Q}{d t^2} = A M^2 e^{m t}$$

and then

$$A e^{m t} (m^2 + 2 a m - b^2) = 0.$$

In order to determine the value of m, it is sufficient to take the two roots of the equation

$$m^2 + 2 a m + b^2 = 0,$$

which can be, real and unequal, real and equal, and imaginary. In the case in which the roots are real, the solution is of the form

$$Q = A e^{m_1 t} + B e^{m^2 t},$$

A and B being two constants, and m_1 and m_2 the two roots,

$$\frac{m_1}{m_2} = -a \pm \sqrt[2]{a^2 - b^2}$$

or for brevity replacing $\sqrt{a^2 - b^2}$ with r which has a real value

$$Q = e^{-a t} \{ A e^{-r t} + B e^{r t} \}.$$

If the roots are imaginary, that is, if $b > a$, the two components $r t$ $e - r t$ are imaginary, and in such a case representing $\sqrt{a^2 - a^2}$ by p.

$$Q = e^{-a t} \{ A e^{p t \sqrt{-1}} + B e^{-p t \sqrt{-1}} \},$$

and by the formula of Moiore

$$e^{p t \sqrt{-1}} = \cos p t + \sqrt{-1} \sin p t$$

$$e^{-p t \sqrt{-1}} = \cos p t - \sqrt{-1} \sin p t,$$

whence we get

$$Q = e^{-a t} \{ (A + B) \cos p t + \sqrt{-1} (A - B) \sin p t \}$$

$$= e^{-a t} \{ M \cos p t + N \sin p t \} \qquad (y)$$

The general equation (x) therefore admits of two species of solutions: one exponential and one trigonometrical of the values $\frac{R}{L}$ and $\frac{1}{C L}$; the limits of passage from one species of solution to the other is represented by the case of equal roots or by $R_0 = \sqrt{\frac{4 L}{C}}$, below which value of the resistance (which may be called critical) the solution is always trigonometrical. Let us now study more particularly the character of the current of discharge in these last conditions, determining

$$i = \frac{d Q}{d t} \text{ from } (y)$$

$$i = \frac{d Q}{d t} \; a \varepsilon^{-d t} (m \cos p t + n \sin p t) + p e^{-a t} (m \sin p t - n \cos p t)$$

$$= \varepsilon^{-a t} (a m - p n) \cos p t + (a n + p m) \sin p t \qquad (z)$$

To determine the constants m and n we observe that for $t = o$, $Q = Q_0$, and $i = o$, then from (y) and from (z)

$$m = Q_0, \; n = \frac{a Q_0}{p},$$

and

$$Q = e^{-a t} Q_0 \left\{ \cos p t + \frac{a}{p} \sin p t \right\}$$

$$i = e^{-a t} \left\{ \frac{a^2 Q_0}{p} + p Q_0 \right\} \sin p t =$$

$$e^{\frac{-R t}{2 L}} Q_0 \frac{\frac{1}{C L}}{\sqrt{\frac{1}{C L} - \frac{R^2}{4 L}}} \sin \sqrt{\frac{1}{C L} - \frac{R^2 t}{4 L}}$$

3. If f is the attractive force between the two armatures of an electrostatic condenser, we find that the pressure exercised in the dielectric in all directions in the act of charging is represented by

$$p = \frac{f^2}{8 \pi K};$$

K is the coefficient in the general expression of Coulomb on electric action.

4. In the electrostatic system of units, the capacity, being homogenous of one length, is expressed in centimetres.

5. Also applied recently by Professor Frölich in a series of studies carried out in order to demonstrate the movements of telephonic diaphragms.

6. As we know, the index of refraction for a given substance is the constant ratio between the sine of the angle of incidence and that of the angle of reflection of a given ray.

7. Oct. 25, 1889. Dr. Berthelot, *Revue Internationale l'Electricité*.

8. Vues nouvelles sur l'induction telephonique, par J. Carby (*Lumière Electrique*, Janvier 11, 1890).

Municipal Ownership of Industries.*

BY ALLEN R. FOOTE.

Those who know me know that this is a subject in which I take a deep interest and on which I have an opinion. As I had no opportunity to learn what Prof. Edward A. Bemis, of the Vanderbilt University, of Nashville, Tenn., would say in his paper on "The Municipal Ownership of Gas Works in the United States," it has not been possible for me to prepare a review or a discussion of his presentation of the subject. I shall therefore discuss it in general terms.

So far as I am aware, the policy of the municipal ownership of the manufactured gas industry is advocated by professors of economy on the broad ground that it is a means of securing an economic advantage for society.

I presume such professors will agree with me in the general statement that that system of economy is best which most surely tends to enable the poorest member of society to become richer. To reach a solution of this problem, it is

* This paper was written with the expectation that an opportunity would offer to read it before the American Economic Association at its fourth annual meeting, held in Washington, D. C., Dec. 26-30, 1890. After Prof. Edward W. Bemis had read his paper on "The Municipal Ownership of Gas Works in the United States" no such opportunity occurred for want of time. It is presented to the public with the request that it receive careful consideration and well thought-out criticism.—A. R. F.

necessary to inquire in what way does the policy of municipal ownership tend to enable the poorest member of society to become richer? Two differing methods for manifesting the economic advantage to be gained by such ownership are in operation. (1) Operating the plant for the purpose of creating a profit; the profit being used to reduce taxation for special or general purposes. (2) Operating the plant without the intention of making a profit, for the purpose of supplying consumers at actual cost of production.

For the purpose of the present inquiry I will not consider any question relating to the initiative of the ownership or to the administration of the plant. For the sake of the argument I will concede that everything in that direction is all right, and that the plant and its operation is an exposition of the best attainments possible to municipal ownership. This enables thought to concentrate upon the direct question in issue. To solve the problem the effect of each method of economic manifestation must be considered upon its own merits.

Let us consider the operation of a municipal plant for a profit, the use of the profit being to reduce taxation. Gas for illuminating or heating purposes is a commodity of consumption, therefore the profit made by a municipality on the sale of gas is a tax on consumption. It is self-evident that the higher the price of the gas the greater the profit will be, up to the taxable limit of the industry. The greater the profit the larger the fund to be used for the reduction of special or general taxation. The selling price is the same to all consumers. The profit per 1,000 feet on the gas consumed by the poor is exactly the same as the profit per 1,000 feet on the gas consumed by the rich. Under this system the poor not only pay the same rate of tax per 1,000 feet as the rich, they also consume much more gas per dollar of their income than do the rich. These two facts, fairly considered, fully justify all the fine frenzy of denunciation of indirect taxation to be found in the fourth chapter of "Taxation in American States and Cities," by Prof. Richard T. Ely. The character of indirect taxation, as described by this author, may be sufficiently indicated by a quotation of some of the head lines of the subdivisions of this chapter. They are as follows: "Indirect taxes are chiefly taxes on commodities;" "Indirect taxes violate the principle of equality;" "Indirect taxes and pauperism;" "Indirect taxes obstruct trade;" "Indirect taxes congenial to despotism and aristocracy."

In view of such teaching one must conclude that the economic results of operating a municipal plant to create a profit tends to make the rich richer and the poor poorer, a result the reverse of that which should be realized by an economic system designed to secure "the greatest good for the greatest number."

In this result may be found a logical reason why "the best people" in a community, where such a system is in vogue, desire its continuance. Under such conditions any man having a large income can afford to pay twice or three times the price he does for the gas he consumes, since the amount saved to him, through the reduction of his taxes by the profit on the gas bills of a thousand other consumers, is far greater than his share of the excess of price. This is why the citizens of Philadelphia are to-day paying one dollar and a half per 1,000 feet for gas, when, if the plant were owned and operated as a private industry, the price would be but one dollar per 1,000 feet. Every wealthy man in Philadelphia has a thousand poor people assisting him to pay the just taxes of wealth. The poor deluded creatures are content to do this, because they think by owning their own gas works they have slipped from under a grinding monopoly. This criticism shows that an apprehension of wherein lies the economic advantage in any problem is an instinct with the rich, while if the poor have it at all, it is with them an acquired taste. It further explains why there are two classes of people, the rich and the poor.

Of the two methods considered, operating a municipal plant for the purpose of suppling consumers at the cost of production is the most equitable. By it, the rich gain only the advantage of the saving on the gas they consume, and the gain of the poor is on the same basis. The gas bills of the poor being a larger percentage of their income than are the gas bills of the rich, the economic advantage gained by the poor under this method effects a larger percentage of saving for the poor in proportion to income than it does for the rich. Therefore this method "tends to enable the poorest member of society to become richer." It obtains "the greatest good for the greatest number." It causes, so far as the economic advantage is concerned, the poor to grow richer, and the rich to grow poorer, because it leaves the taxes for the rich to pay. This would be the result of an equitable distribution of wealth.

It is evident from the foregoing if the economic advantage obtained by the community through the price paid for this service is to decide policy of municipal ownership of industries, then those who advocate private ownership must accept the issue on this basis, and be ready to show that they can and will perform the same service for the same price that the community pays for it under municipal ownership and administration.

A condition precedent to the settlement of this question is an agreement on what constitutes cost of service under municipal ownership. It was to establish this agreement that I offered the resolution Saturday evening last after Prof. Henry C. Adams had read his admirable paper on "Statistics as a Means of Correcting Corporate Abuses." Please notice carefully the wording of those resolutions. They are:

"*Resolved, First*, That a committee be appointed to designate the divisions of accounts, and the items to be included in each, that should be kept by corporations performing quasi-public services.

"*Resolved, Second*, That said divisions be so made that the effect of each essential economic factor will be shown, to the end that correct statistics may be obtained through a uniform method of accounting, as a basis for intelligent economic discussion and legislation."

We must first agree on what items constitute cost, then we must see to it that these items are honestly included in all statements of cost. This done, we are in a position to take intelligent action, and may then award the contract to the municipality or to private enterprise, whichever, in the light of the facts so obtained, may appear to be to the best economic advantage of the greater people, those who toil and are poor.

Assuming that no economist will take issue with me regarding this fundamental basis for an agreement, I will advance one step farther and claim, until such a basis is agreed upon and the accounts are made in accordance with its requirements, there shall be a suspension of judgment and action. By adhering to this policy all parties will not only avoid the liability to get into positions from which they will have to recede when the statements of cost are correctly made, but large invested interests will cease to suffer from attacks that would not be made if those who utter them were better informed.

I urge this claim upon you for another reason. I, like all, not to the manor born, have a lofty ideal of nobility. I feel it to be a personal belittlement to be obliged to lower it. According to my ideal, the noblest men are they who worthily fill the station of teacher. What wonder is it then that I should feel hurt when I see some who occupy such stations giving currency to statements that tend to lessen the respect for, and therefore the influence of, those who utter them. When professors of economy give currency to statements of the cost of production which practical men, in the light of the accounts they are daily keeping, know are not true, they must not wonder if they find themselves and the educational institutions with which they are connected held in small estimation. The profession cannot afford this, any better than business interests can afford to suffer from the attacks of the uninformed. Here again, I think, we have a point of agreement. Let us join hands upon it and take as our guide to action, "Whose cause truth will not serve is lost." That truth may be established, no statement of a demonstrable fact should be made without an analysis of the conditions to show that the conclusion reached is correct.

Having in part explained my views and position to you, I feel it right to tell you I look upon statistics as being as potent a means of correcting the abuse of corporations as for correcting abuse by corporations. To sustain myself in opposing the principle of governmental ownership of industries, in whatever form it may take, I invoke the same power as do those who favor that principle.

Take the accounts of all the industrial plants owned by municipalities, and write them up completely from the date of their initiative until now, and you will find that the communities that have entered upon those experiments have not gained an economic advantage. Private enterprise stands ready to-day to take over every one of these plants and perform the service at the same price such accounts will show it is costing the community where it is rendered, provided the municipality will grant the same economic advantages assumed by itself, which are: An untaxed investment, and untaxed, exclusive and perpetual franchise.

Electric Lighting Progress in London.*

BY F. BAILEY.

The last paper on electric lighting read before the society was by Mr. R. E. B. Crompton, in 1888, when he placed before you some of the difficulties and obstacles which were retarding the progress of electric lighting. The rapid progress made within the last eighteen months will, however, show that these difficulties have to a great extent been removed by a number of supply companies having obtained Parliamentary powers to lay mains within certain specified areas into which London has been divided. I propose, therefore, to place before you in general terms the work done and in progress by the various companies, as the time at my disposal will not permit me to give minute details of generating stations and systems.

Although the development of electric lighting has been so rapid within the last ten years, it must not be forgotten that the arc light was shown at the Royal Institution in 1809, and remained a scientific curiosity until 1848, when Staite gave a public exhibition of his arc lamp from the portico of the National Gallery in Trafalgar Square. The *Illustrated London News* of that time contains a drawing of the scenes with the following remarks: "The electric light possesses no novelty. Year after year it has been exhibited at every course of philosophical lectures since the time of Sir Humphry Davy, and therefore really its practicability forms the whole subject for consideration." The electrical energy for this light was obtained from a primary battery; and it is probable that the practicability of this method of obtaining light will continue to remain a subject for remote consideration. At this time the seed sown by Faraday's discovery, in 1831, of electro-maguetic induction had fallen on fruitful soil; and the wonderful dynamos of to-day form a suitable monument to his genius.

*Paper read before the Society of Arts, December, 1890.

You will see, therefore, that electric lighting commenced its career in London, and London ought, therefore, to show the greatest progress. The incandescent lamp, in some form or another, is mentioned almost yearly from 1836 onward, and I propose at once to jump to the period when Swan, in England, and Edison in America, brought out the present form of lamp.

Through the kindness of Mr. J. W. Swan, I have the honor to show you the first lamp he made. It is to be hoped that this lamp will eventually come under the care of one of our great museums, in order that future ages may recognize the genius of Mr. Swan.

I have also to thank Mr. Sydney Morse for the loan of another valuable historical lamp, this being the first lamp constructed by Edison.

Time does not permit me to trace the history of the incandescent lamp, or the extraordinary development of its manufacture. Nothing could have been done practically without the mercury pump, and we ought, therefore, to place the inventor, Dr. Sprengel, in a high position on our records of pioneers.

Turning to the record of general distribution of the electric light in London, you all know that practically nothing was done under the Act of 1882, but private enterprise provided fields for encouraging the efforts of the electrical engineer, and foremost among these must be mentioned the Grosvenor Gallery station, which did such good service in making the capabilities of the light known, and in proving the absolute necessity that existed for it; for however defective the supply may have been toward the close of the existence of the station (owing to the plant being overloaded), we owe a debt of gratitude to Lord Crawford for his energetic support to this enterprise, and to those who worked so hard to bring it to perfection. Mr. Ferranti and those who worked with him at the Grosvenor laid the foundation stone of a satisfactory transformer system, and as they had no Parliamentary powers to lay down underground mains, overhead lines were run in all directions. The perfection to which they brought the details of overhead construction is so fully proved by the absence of accidents that it is much to be regretted that the overhead conductors in the United States were allowed to have been put up with no regard to common sense or safety.

It is frequently stated that the Electric Lighting Act of 1882 did much towards stifling inordinate speculation; but in attempting to make people wise by this act of Parliament, a very serious check was placed upon the development of electrical progress.

The enormous strides which have been made under the more encouraging Electric Lighting Act of 1888 will convince every one that it was urgently required, and electrical engineers fully realize what they owe to Sir Frederick Bramwell for his share in framing this act. One of the consequences of this act was a deluge of applications for provisional orders. A court of inquiry was therefore ordered by the Board of Trade, who appointed Major Marindin as their inspector for this purpose.

If you carefully read the eighteen days' evidence given, you will probably be convinced that every system was the best. The inquiry lasted several days, and resulted in the granting of provisional orders, confirmed by Parliament in August, 1889, to the companies mentioned in the summary on the following page, which includes other information.

I must here gratefully acknowledge the very cordial assistance which the engineers of the various companies have given me.

We will now very briefly go round the stations of the companies, commencing with

THE KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHT COMPANY.

This company commenced work under the name of the Kensington Court Electric Light Company in the autumn of 1886, and under Mr. Crompton's able guidance made such rapid progress that they commenced to supply current in January, 1887, using underground mains and running their plant in a temporary building; the Board of Trade license under which the work commenced being incorporated in the company's provisional order of 1889, which authorizes them to supply a portion of the parish of Kensington, St. Mary Abbott, and the detached portion of the parish of St. Margaret, Westminster.

The direct current is employed in conjunction with "Howell" secondary batteries, the pressure being 200 volts on the three-wire system, with 100 volts in the houses.

The batteries are charged at any convenient time when the engines have power to spare, and not only act as a sponge, which can be squeezed when the engine plant requires assistance, but also act as regulators, as well as maintaining the supply during the hours of minimum demand. The satisfactory use of secondary batteries in this manner has attained its present development mainly through the indefatigable labors of Mr. J. C. Howell.

Two generating stations are erected, one at Kensington court, and the other at Chapel place, Knightbridge, the plant consisting of Babcock & Wilcox boilers and exhaust steam feed water heaters, Willans compound engines combined direct with Crompton dynamos and Howell batteries in both stations. There is also a battery station situated near the centre of the Kensington district at Queen's Terrace mews, where two large Howell batteries are placed. In all cases ample space is provided for the future extension of the plant when required. Arrangements are provided on the Kensington court station switchboards to enable any dynamo to be used for charging the distant battery station, to which a pair of charging mains are laid. Mr. Crompton also designed for this company a system of mains of considerable novelty which was severely criticised at the time but has since proved most satisfactory.

Culverts constructed with concrete or brick work are laid under the pavements, and bare copper conductors, supported at intervals by glass insulators, are placed in these culverts. The conductors are composed of copper strips, one inch by one-quarter inch, laid one over the other so as to make up the total section required. In cases where there is no room under the pavement in which to build up the culvert, wrought iron gas tubing is used, and cables insulated with thick vulcanized rubber are drawn through and connected to the bare conductors. Numerous service boxes are fixed in the pavements to enable houses to be connected without opening the ground. Four and a half miles of pipes with cables have been laid.

On Dec. 1 lamps were connected to an equivalent of 24,850 32-watt lamps, and Mr. W. H. Miller, the company's engineer, to whom I am indebted for these particulars, informs me that the lamp supply, or maximum number of lamps in use at one moment, is between 30 and 40 per cent. of the lamp connection.

THE HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY.

This company, as you see on the map on the wall, covers a large area, which consists of two detached districts, North Kensington and West Brompton. The generating station is situated off the Richmond road, West Brompton, and contains space for a very large plant.

The Lowrie-Hall alternating current transformer system is adopted with 2,000 volts on the mains. Four principal mains at present carry the current from the station, the transformers being connected to these mains where required. Cast iron pipes are laid to form a conduit into which vulcanized india-rubber Silvertown cables are drawn, suitable manholes, covers and junction boxes being provided.

At present the demand for light is supplied from a plant consisting of:

Three Babcock & Wilcox boilers, working at 150 pounds per square inch.

Three Fowler compound horizontal engines, each of 200 indicated horse power.

Three Lowrie-Hall alternators, each of 100 units, 2,000 volts.

Three Elwell-Parker exciters, each of three units.

The engines work at a speed of 88 revolutions per minute, each engine driving one alternator by seven cotton ropes, the exciter for each alternator being driven by cotton ropes from the alternator pulley.

The Lowrie-Hall pressure regulator and recording instruments are also used. Mr. Hall, the company's manager, has kindly given me this information, and states that on their lamp connections, equivalent to 12,898 lamps of eight candle power, the maximum lamp supply is equivalent to 5,430 lamps of eight candle power—say 42 per cent.

ST. JAMES' AND PALL MALL ELECTRIC LIGHTING COMPANY.

This company was formed for the purpose of supplying the whole of the parish of St. James', Westminster, and commenced to supply current under its provisional orders from its station in Mason's yard, Duke street, on April 4, 1889.

The direct current is employed without batteries.

At present the above station supplies the southern half of the district, the total plant consisting of:

Five Davy-Paxman boilers, working at 150 pounds per square inch.

Two large Berryman feed water heaters.

Ten Willans compound engines, each of 200 indicated horse power.

Two Willans compound engines, each of 80 indicated horse power.

Twelve dynamos, Latimer Clark, Muirhead & Co., and Siemens, driven direct from the engines.

The whole of this plant is neatly arranged, so as to occupy the least space.

The mains consist of a network of conductors on the three-wire system, supplied at about 100 volts at the station by suitable feeders. A cast iron trough or culvert is laid under the surface of the pavement, and three conductors, each consisting of a number of strips of bare copper, which can be added to at any time, are carried by porcelain bridges placed at suitable intervals apart. To avoid any risk of the mains touching each other, porcelain distance pieces are placed over the mains. A cast iron lid with water-tight joint covers the trough. Connection to customers' houses is made by drawing well insulated cable through gas tubing, which is screwed into the trough.

On Dec. 5 a total equivalent to 23,174 lamps of eight candle power were connected. Mr. Dobson, the company's engineer, kindly informed me that the maximum lamp supply is equal to about 13,223 lamps of eight candle power, say 57 per cent.

THE WESTMINSTER ELECTRIC SUPPLY CORPORATION.

The district in which this corporation is authorized to supply electricity by its provisional order comprises that portion of the united parishes of St. Margaret and St. John, Westminster, which lies to the south of the centre line of the Metropolitan District Railway, and the portion of the parish of St. George, Hanover square, covering Belgravia and Mayfair.

The system adopted is similar to that of the Kensington and Knightsbridge Company, direct current in conjunction with batteries used as regulators, and also for supply during hours of minimum demand.

Three stations are being erected, one at Millbank street, one at Eccleston place, and one in Davies street.

Current is now being supplied from the Millbank street station and from a small temporary station in Dacre street. The other two are being pushed forward as fast as possible, in order to supply from all stations early in the year.

Mains are being laid for a three-wire distribution, Messrs. Crompton being the contractors for the Westminster district, where the system adopted is similar to that put down by Mr. Crompton for the Kensington and Knightsbridge Company.

For other parts of the district Prof. Kennedy, the engineer to the company, has devised the arrangement shown in the plan on the wall; bare copper strip rests on stoneware insulators placed from six to eight feet apart, and bedded in the concrete culvert as shown. The copper is stretched by a special tool before being pulled in, and this process gives it sufficient stiffness not to sag perceptibly between the insulators. The total sectional area of the conductors can be increased when required by the addition of more copper strip. Feeders are used in a most systematic manner, and Prof. Kennedy is to be congratulated on the favorable prospects of this company's work. There is a large demand for light in the district, and the rapid progress of this company justifies the expectation of a speedy supply from the stations now in progress.

THE LONDON ELECTRIC SUPPLY CORPORATION.

The parliamentary powers possessed by this company

THE ELECTRICITY SUPPLY CORPORATION.

This company obtained a provisional order in 1889 for supplying the whole of the parish of St. Martin's-in-the-Fields. Direct current, without batteries. The station is placed just off the Strand, and was laid down, some years ago, by Messrs. Gatti to supply the Adelaide Gallery and the Adelphi Theatre; it is now being extended. At present the plant consists of:

Four Babcock & Wilcox boilers.

Five Willans engines, amounting to 600 indicated horse power.

Five Edison-Hopkinson dynamos, each being driven direct from one engine. Callender mains are laid down in Callender-Webb casing.

ST. PANCRAS VESTRY.

The Vestry have decided to carry out the electric lighting of the parish themselves, and have secured the able services of Prof. Robinson as their engineer. The direct current system will be adopted, and a station is now being erected in Stanhope street, Euston road, for the supply of the southwest portion of the parish.

NOTTING-HILL ELECTRIC LIGHTING COMPANY.

The provisional order granted to this company includes the district of Notting-Hill, which comes within part of the parish of Kensington, St. Mary Abbott.

The system is similar to that adopted by the Kensington & Knightsbridge Company.

The first generating station, situated off High street, Kensington, is now approaching completion, the plant consisting of Babcock & Wilcox boilers, Willans engines, Crompton dynamos, and Howell batteries; Crompton's mains are also laid as shown in the map on the wall.

THE METROPOLITAN ELECTRIC SUPPLY COMPANY.

The Parliamentary powers of this company include the large and important districts of Paddington and Marylebone parishes, with part of St. Martin's-in-the-Fields, the

ELECTRIC LIGHTING COMPANIES IN LONDON.

Name of company.	Capital (nominal).	Number of years in existence.	Stations.	Total indicated horse power engines.	Number of lamps equivalent to 32 watt lamps now connected.	System.	Length of conduit pipe, or single run of main.	Lamps per mile.	Meters. No.	Meters. Type.	Districts.
London Electric Supply Corporation, Ltd...	£1,250,000	5	Deptford converting stations	4,500	38,000	Alternate current transformers (Ferranti).....	.....	.....	136 174 14	Ferranti-Mercury. Ferranti-Wright. Frager.....	Parishes of St. James, St. George Chelsea, Rotherhithe, Bermondsey, Clerkenwell, St. Mary, Newington, Lambeth (part of), St. Martin (part of), St. Margaret and St. John, Westminster. Greenwich district, St. Olave district, St. Savior's district.
Metropolitan Electric Supply Co., Ltd.....	500,000	2½	Whitehall..... Sardinia st..... Rathbone pl..... Manchester sq..	600 3,000 1,200 2,000	44,598	Direct current and batteries..... Alternate current trans. (Westinghouse)..... Do. (Parker).....	30 miles.	1,486	25 378	Aron..... Westinghouse.....	Parishes of St. Martin's-in-the Fields (part of) Bill, 1889, Mid-London Order; the Board of Works of St. Giles' district, Holborn district, Strand district, 1889; West London Order, parish of St. Marylebone, 1889; Paddington Order, parish of Paddington, 1890.
House-to-House Electric Supply Co., Ltd.....	350,000	2	West Brompton.....	600	12,898	Transformers (Lowrie-Hall).....	8½ miles.	1,517	71 168	Lowrie Hall. Westinghouse.....	Parish of St. Mary Abbott, Kensington (two portions of).
Westminster Electric Supply Co, Ltd.....	214,765	2	Millbank st. ..... Dacre st.*..... Eccleston pl.† ..... Davies st.†.....	.....	7,540	Direct current and batteries.....	.....	.....	93	Aron.....	Parishes of Westminster, Belgravia, and Mayfair.
Kensington and Knightsbridge Electric Supply Co., Ltd.....	300,000	4	Kensington ct..... Chapel pl.	1560, and Howell batteries.	24,850	Direct current and batteries (Crompton).....	10½ miles.	2,366	200 90 34	Aron..... Hookham... Aubert..	Central Kensington and Knightsbridge.
Chelsea Electric Supply Co...	108,000	6	Draycott pl. and three distributing stations.....	Batteries E. P. S.	19,500	Direct current and batteries (King). §.....	.....	.....	.....	.....	Parish of St. Mary Abbott, Kensington (portion of).
Notting-hill Electric Supply Co.....	100,000	1	High st.‡.....	.....	.....	.....	.....	.....	.....	.....	Parish of St. Mary Abbott, Kensington (portion of).
St. James and Pall Mall Electric Supply Co.....	100,000	2½	Duke st.	1,960	23,174	Direct current.....	4¼ miles.	5,452	190	Aron.....	Parish of St. James.
St. Pancras Vestry.....	.....	.....	Stanhope st.†.....	.....	.....	Direct current.....	.....	.....	.....	.....	Parish of St. Pancras.
The Electricity Supply Corporation, Ltd. (formerly Messrs. Gatti)...	.....	.....	Strand	600	8,500	Direct current...	.....	.....	.....	Frager...	Parish of St. Martin's-in-the-Fields.
				Total.....	179,060	Lamps equivalent to 8 c. p. each.....		Total..	1,573		

* Temporary station. † Now in progress. ‡ Nearly complete, and another station not yet commenced. § As published in the *Engineer* (London), October 24, 1890.

cover a large area, comprising the district bordering the south side of the Thames from Westminster bridge to Greenwich, Mayfair, Belgravia, St. James and Pall Mall, St. Martin's-in-the-Fields, part of Westminster, Chelsea and two isolated areas, namely, Newington and Clerkenwell.

The Ferranti system is employed throughout, alternating current being generated at an extra high pressure and transmitted to converting stations, from which it is distributed at high pressure to the service converters.

The corporation has erected a large station at Deptford, which has been admirably designed for the purpose, having road frontage wharfage and coaling dock. The plant consists of 24 Babcock & Wilcox boilers, four compound vertical engines by Hick & Hargreaves, two of which are 1,500 indicated horse power each, and two of 750 indicated horse power each. There is almost unlimited room for future extension.

Each of these engines drives a Ferranti dynamo by cotton ropes, the exciters being driven direct from independent engines.

In order to convey the high pressure from Deptford to London, Mr. Ferranti devised a special form of main for this purpose, which has been frequently described.

About 28 miles of these mains have been said, the distributing mains from the converting stations being of various kinds. This company's Grosvenor Gallery station having lately been closed, a hurried change has had to be made in order to enable the corporation to supply from Deptford.

CHELSEA ELECTRICITY SUPPLY COMPANY.

This company's provisional order covers the whole parish of Chelsea, a portion of which the company is now supplying.

Direct current is employed with accumulators, but, unlike the other companies in London, in this case the accumulators are charged with a high pressure current, and discharge direct at low pressure into the mains. I am not in possession of any information of this company's progress. From published descriptions you will doubtless be aware that the generating station is situated at Draycott place, with battery stations at Clabon-mews, Egerton-mews and Pavilion road.

Holborn and Strand district, and St. Giles' Board of Works.

Various systems are employed by this company, both the alternating and direct current systems being adopted.

The company is at present supplying from four stations, and it may perhaps be better to describe them separately.

The Whitehall station, situated in Whitehall avenue, is a direct current station which possesses no novelty and supplies the surrounding locality, the plant consisting of Hick-Hargreaves boilers, Willans engine, and Siemens dynamos. Callender mains are laid down the Northumberland avenue subway and elsewhere.

The Sardina street station contains a complete plant on the Westinghouse alternating current system, consisting of 12 Babcock & Wilcox boilers, working at 150 pounds per square inch; 12 Westinghouse alternators, each being belt-driven by a Westinghouse compound engine. There are also three exciters, each being belt-driven by its own engine.

The Manchester square station contains nine Babcock & Wilcox boilers, ten Parker alternators, each driven direct by a 200 h. p. Willans engine, as shown in the sketch of the engine house placed on the wall. There are also four exciters, each being driven direct by a Willans engine. The steam piping is arranged on a method devised by Mr. J. H. Rosenthal, the London manager of the Babcock & Wilcox Boiler Company, and possesses many advantages.

The Rathbone Place station contains plant of a similar kind, there being five boilers, six alternators and engines, two exciters and engines.

The system of distribution from the three latter alternating current stations is of a simple description—cast-iron pipes laid underground form conduits, into which Silvertown vulcanized rubber cables have been drawn when required. Split T-pieces are inserted in the pipes for connection to customers' premises. These mains are looped from house to house, returning to the station, so as to form complete rings. Each customer has, therefore, a duplicate supply, thus enabling new customers to be connected to the system without interrupting the supply on the circuit.

All these three stations are connected together by trunk mains, which enable one station to assist another, or take the whole load of the district during the hours of least de-

mand. The current leaves each of these stations at a pressure of 1,000 volts, this moderate pressure being adopted as the number of supply stations reduces the distance to which each cable has to be laid to meet the demand. The whole supply is distributed by a number of small cables, which can be easily replaced when required.

The demand for light has been very encouraging; and, as you will see from the table, the progress of the lamp connection to these stations has been very rapid. I regret, however, to say that, although this company at present supplies light to 12 public houses, only four churches are, so far, connected with the system.

Having now completed our tour of the stations of the various companies, we have seen how the streets of London have lately been disturbed in order to lay all these mains; no doubt a certain amount of inconvenience has unavoidably been caused to traffic, but it has revealed the wonderful system of organization by which London is governed; and the vestry surveyors, whose labors have been much increased, have not only afforded every facility for carrying out the work, but have rapidly reinstated the pavements at, of course, the cost of the respective electric light companies. The public, therefore, though for a short time inconvenienced, have in reality secured new pavements for old.

Summarizing the plants adopted by the various supply companies, it is interesting to notice how the peculiar conditions of electrical supply in the very limited space usually available have been provided for by manufacturers. As an instance of this, it may be noted that Willans engines, amounting to about 9,000 h. p., are used by the public supply companies in London, and similar engines, aggregating more than 2,000 indicated horse power, for private plants in the metropolis. The Babcock & Wilcox boiler having also been so universally adopted, it may be of interest to state that 78 boilers of this type, supplying 14,230 indicated horse power, are now at work in London.

PRIVATE PLANTS.

One result of the act of 1882 has undoubtedly been to cause a large number of private installations to be erected, but so many of our leading electric light contractors have laid down thoroughly efficient plants that there is perhaps no cause for regret. Most of the large terminal London railway stations work their own electric light machinery, the largest installation being at Paddington, where the Great Western Railway Company have machinery of 1,500 h. p. for this purpose. For residences, gas engines provide the motive power for driving dynamos supplying about 18,000 lamps of 32 watts each, the remainder being steam-driven.

It may be of interest to note that the Crossley Otto gas engine, which was awarded a gold medal at this society's recent motor competition, is being employed for this purpose, among others, by Messrs. Laing, Wharton & Down. This total may appear large, but it must be remembered that many of the large hotels having their own steam plant for working lifts, warming and cooking, have added electric lighting machinery; the total also includes the lamps at D'Oyly Carte's new theatre, where Messrs. Verity have erected a plant so complete that it may almost be considered as a small central station.

NUMBER OF INCANDESCENT LAMPS NOW IN USE IN LONDON.

With the kind assistance of the electric light contractors, particularly Messrs. Verity, Laing, Wharton & Down, Phipps & Dawson, Drake & Gorham, Sharp & Kent, and many others, and the public supply companies, I have been able to collect data that the total equivalent number of 32-watt lamps now in use in London is approximately as follows:

Public supply companies	179,060
Private plants	85,000
Total	264,060

At the present rate of increase a very moderate estimate gives an addition of at least 4,000 lamps per week, and there is little doubt that this number will be greatly exceeded at no distant date.

All these incandescent lamps have been calculated on a basis of 32 watts or eight candle power lamps, as experience has shown that this is a size much used in London, and by taking the smallest lamp we avoid dealing with half lamps.

Before leaving these particulars, it will probably be of service to the designers of future stations if we tabulate the data collected.

TABLE SHOWING PERCENTAGE OF MAXIMUM LAMP SUPPLY AT ANY MOMENT TO TOTAL LAMP CONNECTION.

Station.	Percentage.
House-to-house	42
Kensington and Knightsbridge	30 to 40
St. James and Pall Mall	57
Sardinia street	45
Rathbone place	64
Manchester square	45

It may perhaps be of interest if I draw your attention to the following table, based upon data which have come under my observation, showing the candle power of lamps mostly used:

LAMPS (50 VOLTS).

8 c. p.	16 c. p.	32 c. p.	50 c. p.	100 c. p.	200 c. p.	500 c. p.
597	1,666	62	13	8	8	3

LAMPS (100 VOLTS).

5,437	5,131	176	26	57	40	3

During 1886 and part of 1887 I was able to collect the following data of the behavior of incandescent lamps, each of 25 c. p., with an efficiency of 3½ watts per candle, and I trust that more information of this kind will be collected:

With reference to arc lighting considerable progress is being made; and although the number now in use in London does not much exceed 1,000 lamps, there is no doubt that rapid progress will be made.

Prof. Silvanus Thompson, in March, 1889, showed you all the best known arc lamps; and for further information of their development I must refer to his most complete paper on this subject, published in the Society's *Journal*, March 8, 1889.

It is a matter for regret that there is no progress to be noticed in connection with the efficiency of the incandescent lamp, which remains much the same as it was five years ago. It will be apparent from the table showing the candle power of lamps mostly used that a really efficient 100-volt 8 c. p. lamp is much needed; the present lamps of this kind have such a short life that customers, contractors and electric supply companies would all hail its advent as a boon.

We must also remember that the future progress of electric lighting depends in no small measure on the lamp-makers, and as the manufacture of the incandescent lamp will soon be open to all (owing to the expiration of the present patents) the absolute necessity of a standardizing laboratory must compel its adoption where not only instruments but lamps can be tested, so that people may know when they ask for an 8 c. p. 100-volt lamp, with or without a guaranteed life of, say, 1,000 hours at an efficiency of 3½ watts per candle, that they get what they have asked for.

That this question of lamp efficiency is of importance to customers and supply companies alike few will doubt, and the following table will probably explain itself:

Watts per candle.	Candles per 1,000 watts.	Lamps per 1,000 watts. 8 c. p.	16 c. p.	20 c. p.	32 c. p.
2.00	500.0	62.5	31.2	25 0	15.6
2.25	444.5	55.5	27.7	22.2	13.9
2.50	400.0	50.0	25.0	20.0	12.5
2.75	363.6	45.4	22.7	18.2	11.4
3.00	333.3	41.7	20.8	16.7	10 4
3.25	307.6	38.4	19 2	15 4	9.6
3.50	285.7	35.7	17.8	14.3	8 9
3.75	266.6	33.3	16.7	13.3	8.3
4.00	250.0	31.2	15.6	12.5	7.8

We see then how an improved lamp efficiency will benefit the supply companies, by enabling them to increase their lamp connection.

The following table will appeal most strongly to all users of the incandescent lamp; but it must be assumed that an increased efficiency is not obtained at the expense of a reduced life of the lamps.

The most satisfactory feature, however, of the present Edison-Swan lamps is the uniformity of their voltage; and the scientific department of the Edison & Swan Company's works is to be congratulated on the assistance they have given to the industry by practically enabling voltmeters to be set by photometrical tests of the lamps.

COST PER ANNUM PER EIGHT CANDLE POWER LAMP AT 8D. PER UNIT.

Lamps burning an average of:		½ hour per day.			1 hour per day.			2 hours per day.			3 hours per day.			4 hours per day.		
Hours per annum.		182.5			365			730			1,095			1,460		
Lamp efficiency.	2 watts per candle	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
		0	1	11	0	3	11	0	7	10	0	11	9	0	15	8
	2.25 "	0	2	2	0	4	5	0	8	9	0	13	2	0	17	6
	2.50 "	0	2	5	0	4	10	0	9	9	0	14	7	0	19	6
	2.75 "	0	2	8	0	5	4	0	10	9	0	16	1	1	1	5
	3.00 "	0	2	11	0	5	10	0	11	8	0	17	6	1	3	4
	3.25 "	0	3	2	0	6	4	0	12	8	0	19	0	1	5	4
	3.50 "	0	3	5	0	6	10	0	13	8	1	0	5	1	7	3
	3.75 "	0	3	8	0	7	4	0	14	7	1	1	11	1	9	2
	4.00 "	0	3	11	0	7	10	0	15	8	1	3	6	1	11	4

It may be thought that an estimated use of a lamp for only about 200 or 300 hours per annum is very low, but it should be remembered that the electric light need only be used when it is required, as the ease of switching it on and off makes us forget all our past troubles in hunting for gas taps and matches, and of broken gas-globes. With ordinary care, the average cost of burning an eight candle-power lamp for ordinary domestic use need not exceed ten shillings per annum.

Of course much depends on the wiring contractor, who not only has to be an accomplished art critic in designing or selecting the brackets, pendants, etc., but he also has to suggest the most advantageous positions for the lamps and switches. A switch placed near the door of every room and not less than two lamps in any room will probably save annoyance.

The greatest progress has been made in the wiring of houses; not only is more work done, but it is better done and on more mechanical principles, for whereas some years ago a single main would have been run from top to bottom of a house with numerous T-joints, independent circuits will now be wired, and all brought to a neat form of distributing board.

The effect of the extra care which is now taken with this work is proved by the following table of insulation tests, taken with 100 volts at 200 houses:

INSULATION TESTS OF INTERNAL WIRING (TAKEN WITH 100 VOLTS —EVERSHED OHMMETER).

Number of points.	Average of houses.	Test, Megohms.
5 to 10	15	4.0
10 to 15	23	3.5
15 to 20	18	2.8
20 to 25	13	2.7
25 to 35	33	1.8
35 to 40	12	1.5
40 to 50	16	1.2
50 to 60	12	1.1
60 to 70	9	1.0
70 to 120	14	.4
120 to 220	9	.25

I hoped to have been able to place before you some record of the improvement in the health of London owing to the progress of electric lighting, but so much has already been said and published about it that further facts appear needless. It is simply melancholy to see so many of our churches and halls not only burning their gas jets for lighting but also for "warming" the building. If culpable negligence amounts to manslaughter, the people responsible for this atrocity ought to receive their deserts.

Having now placed before you some account of the progress of electric lighting in London, I must ask you to compare our metropolis with other cities, and leave you to judge whether we are so far behind them as some would have us believe. Is it not more probable that other countries will be glad to avail themselves of the experience which London must gain in the working of so many distinct systems?

INCANDESCENT LAMPS.—LIFE AND NATURE OF FRACTURE.

All Lamps 25 c. p. Brass Collar, Edison-Swan.

Lamps. Volts.	No. of lamps renewed.	Average life hours	Nature of Failure. Glass Globe. Broken	Per cent.	Blackened.	Per cent.	Plaster	Per cent.	Filament Fractured. Loop.	Per cent.	Stem.	Per cent.	Joint.	Per cent.
151	536	861	114	21.2	21	3.91	56	10 44	208	38.80	114	21.26	23	4.29
142	189	789	19	10.0	4	2.11	41	21.69	67	35.45	47	24.96	11	5.82
120	2,549	923	273	10.7	92	3.60	334	13.1	1,114	43.70	693	27.10	43	1.68
99	588	1,423	122	20.0	61	10.37	92	15.64	212	36.00	95	16.10	6	1.02
	3,862		528		178		523		1,601		949		83	
				13.67		4.61		13.54		41.46		24.57		2.15

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

An Improved Market.—The first days of the new year indicate an improved condition of the financial market. A glance at any of the lists from the Eastern stock exchanges shows an increase over December prices. About all the scares, it seems, that could be thought of have been expended by persons interested in the depression of stocks, and the market has found a more substantial basis than for many months past. It is perfectly safe to anticipate a continuation of a steady market. Large purchases of stocks and other securities have a tendency to bring about this result, and as there is a large amount of money seeking investment now the rise will continue. The bond market is beginning to show signs of life, and it is likely that the first of February will see the general bond market much higher because of the increased demand for its securities.

A Favorable Bank Statement was issued Saturday, and was an agreeable surprise. An increase of $851,950 in circulation was shown. The bank statement somehow never fails to have its effect on the general market for stocks. Perhaps it has more influence than it deserves, but there is no denying the fact that a favorable result obtains in most of the stock exchanges of the East if the bank statement for the week looks well and presents an increase of money in circulation.

Stock Purchases for Investment.—People are buying stocks that can be had cheap, and the last few days have seen large purchases for investment. Some persons are of the opinion that they can do better in the stock market at the present figures than they could by purchasing bonds, and there is good reason for their decision. Generally speaking, stocks are cheap and bonds are dear.

Increase of Money in Circulation.—The Treasury Department has issued a statement showing a net increase of $24,199,940 in circulation the first of the year over the first of December last; $12,730,780 in gold certificates, $5,974,700 in gold coin, $4,677,127 in Treasury notes, and $1,640,089 in United States notes. The items of decrease were $1.213.173 in national bank notes and $287,036 in silver certificates. During the month there was an increase of $2,386,773 in the money and bullion in the Treasury, principally in gold coin and standard silver dollars.

No Financial Legislation.—Another statement which comes from Washington, and is almost too good to be true, is that, notwithstanding all the bills that have been introduced for the supposed relief of the financial market, there is little prospect of any financial legislation this winter. The agitation has had its effect, however, and the politician has succeeded in unsettling business from time to time by discussions of what he does not know about finance. A backwoods constituency could never appreciate its representative unless he had introduced a bill in Congress to open the doors of the Treasury and let all the silver loose at once, or proposed something equally ridiculous. A blacksmith could hardly raise more havoc in repairing a watch than these same politicians in trying to mend our financial condition.

Failures in Business.—The last week has seen some failures, perhaps the most important of which is that of Bateman & Co., of New York. The concern failed for about $1,000,000. The failure was brought about by the holding of a large amount of unprofitable railroad securities, on which no money could be raised. For several years this firm did an enormous business on the New York Stock Exchange, but for the last 12 months or so the health of Mr. Bateman has been such as to prevent his former activity, and the concern has not received the business that it formerly had. The result is instructive, because of the fact that one of the reasons for the failure is that the concern has been too long on the bear side of the market.

Failures for the Year.—There were about 11,000 failures in business last year, so reports Dun & Co., and the liabilities are shown to be about $189,000,000, which is $41,000,000 over last year. These are the largest liabilities since 1884.

London Money Market.—The condition of the London market is hardly satisfactory. American stocks have been higher the last few days, but there is a strong prospect that the Bank of England will raise its discount rate very soon, as France is in need of the $3,500,000 loan which it recently made to England.

Phonograph Stocks.—The position of these stocks still continues to be somewhat embarrassed, owing to prospective litigation. The writer is informed that the Automatic Phonograph Exhibition Company has been served with a notice of an appeal to the Attorney-General of the State of New York by one of the subscribers to the company for the annullment of its charter, upon the grounds of alleged violation of the laws of the State of New York and the provisions of the acts and statutes under which the company was incorporated; that the company has no power to lease its personal property for rental in the manner provided by its agreements; that it cannot legally enter into copartnership

with other corporations and has no power to enter into the business of public amusement and cannot transact its business outside the limits of the State of New York. This situation, together with the preliminary injunction at present on the North American Phonograph Company, preventing them from selling phonographs, is not helping the market for phonograph stocks. These companies cannot get together too quickly and settle their differences for the good of their stocks. The writer would not, however, at present advise holders of phonograph stocks to sell at present prices, but rather to see the fight out than make sacrifices of any serious nature.

A Rising Market.—As has been predicted by the writer for the last month or so, electrical stocks have risen with the first of the year. Several of the more prominent stocks show a three point gain for the week. This, surely, is an argument in favor of these securities, as the general market for railroad shares does not show such improvement.

Thomson-Houston.—With the first of the year the Thomson-Houston Company makes its last payment and assumes control of the Brush Electric Company. This property is very valuable and adds greatly to the resources of the Thomson-Houston Company. During the last week of January the annual meeting of stockholders of the Brush Company will take place, and it is likely that an entire new board of directors and officers will be elected. Several minority stockholders of the Brush Company rebelled when they found that their company was to be sold, and suit was threatened because they had no opportunity to sell on the same basis with holders of the majority of stock. This obstacle has been overcome by the Thomson-Houston Company giving the dissenting stockholders "preferred" stock instead of "common" as originally proposed. Half a million preferred stock was issued for the purpose, increasing the capitalization of the Brush Company from $2,000,000 to $2,500,000. The stock of the Thomson-Houston Company has had a good market during the past week, and has risen two and three-quarter points since the last report.

Edison Stock.—This stock has not been particularly active, but has made a good start with the new year. It has gained three points since last week's closing.

Western Union falls in line with other prominent electrical stocks and records a net gain for the week of three and one-quarter points.

Bell Telephone.—This stock, ex-dividend, closed at 209. Closing figure last week, before a dividend was paid, was 210.

Westinghouse.—The market in Pittsburgh for this stock is increasing rapidly and closed with a 13½ quotation. F. Z. M.

The Closing Quotations of electric stocks, from F. Z. Maguire & Co., electrical securities, 18 Wall street, New York, on Saturday, Jan. 3, 1891, in New York, Boston and Washington, and in Pittsburgh, Jan. 2, were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	77¼	77½
American Telegraph & Cable	100	14,000,000	83	80
Central and South American	100	5,000,000	*145	160
Mexican	100	2,000,000	*210	....
Commercial Cable Co	100	7,716,000	103	105
Postal Telegraph Cable	100	5,000,000	39	....
Edison General Electric Co.	100	9,503,500	87	90
" " Deferred	100	2,496,500	....	....
Consolidated Electric Light	100	1,922 400	....	....
Edison Electric Illuminating Co.	100	2,567,800	70	....
United States Electric Light	100	1,500,000	30	....
North American Phonograph	100	6,200,000	....	....
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	43¾	44
" " preferred	25	4,000,000	*25½	26
" " Series C	10	400,000	....	11½
" " Series D	10	120,000	5½	6
" International Co.	100	1,000,000	....	....
Thomson Welding Co.	100	1 000,000	....	200
" European Welding Co.	100	1,000,000	55	....
Ft. Wayne Electric Co.	25	4,000 000	10½	11
Telephone:				
American Bell	100	12,500,000	209	..
Erie	100	4,800,000	46	47
New England	100	10,304,600	50½	51
Mexican	10	1,280,000	70c.	80c.
Tropical American	10	400,000	.	1¼
MISCELLANEOUS.				
Edison Phonograph Doll	10	1,000,000	1½	2
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	34
Chesapeake & Potomac	100	2,650,000	61	73
American Graphophone	10	600,000	12¼	12¾
United States Electric Light (Washington)	100	300,000	*135	145
Eckington and Soldiers' Home Electric Ry.	50	352,000	58	59
Georgetown and Tennallytown	50	200,000	48	55
PITTSBURGH.				
Westinghouse Electric Mfg. Co.	50	5,000,000	13½	....

Col. S. G. Lynch, broker, of 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$298@$300	Rocky Mountain Bell	$40@$45
Central Union	57@ 58	Cumberland	59@ 60
Michigan	91@ 93	Wisconsin	118@ 120
Great Southern	32@ 35	Bell of Missouri	155@ 160
Iowa Union	20@ 21	Missouri and Kansas	55@ 57
Colorado	38@ 40		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$85@$90	Chicago Edison Co	$128@$130

NEW INCORPORATIONS.

The Delaware Lighting Company, of Philadelphia, with a capital of $50,000, has been granted a charter.

The Riverside Edison Company, with a capital stock of $40,000, has been incorporated at Riverside, Ill.

The Dixon Street Railway Company, of Dixon, Ill., has been incorporated with a capital stock of $150,000.

The Prouty Street Car Motor Company has been incorporated at Chicago, Ill., with a capital stock of $500,000.

The New Albany and Light Power Company, New Albany, Ind., has been incorporated with a capital stock of $100,000.

The Schuylkill Lighting Company, of Philadelphia, with a capital of $50,000, has been granted a charter by the State officials.

Memphis, Tenn.—The Cronbus Chemical Electric Company has been incorporated by A. W. Allison, B. M. Stratton, W. H. Bates and others, to establish an electric light and power plant.

St. Augustine, Fla.—Heth Canfield, C. D. Blauvelt, George Old and others have incorporated the electric belt line railway company. The company has a capital stock of $75,000, and six lines of electric railway will be built.

Seneca, S. C.—The Piedmont Construction and Land Company has been incorporated by W. J. Kirk, Albert Zimmerman, J. W. Bonden and others, to erect an electric light plant and to establish other enterprises. The company has a capital stock of $20,000.

Morganton, N. C.—The Morganton Development Company has been incorporated by J. H. Pierson, I. F. Avery, H. W. Connelly, J. A. Lackey and W. C. Ervine, to establish a number of enterprises, among which will be an electric light plant. The capital stock of the company is $500,000.

The Idaho Electric Light and Power Company has been formed to carry on a general electric light and power business. The principal place of business is Wallace, Shoshone County, Idaho, and the corporate life is to be 50 years. The directors named are Charles W. O'Neill, Frank C. Loring, Fred E. Lucas, Charles A. Wing and Ely P. Spaulding. The capital stock is $500,000 in 50,000 shares.

The Salamanca Electric Surface Railway Company, with a capital of $100,000, has filed articles of incorporation at Albany, N. Y., with the Secretary of State. The company is formed to build an electric railroad about six miles in length through various streets and avenues in the town of Great Valley and in the villages of Salamanca and West Salamanca in Cattaraugus County. The directors of the company are: Hudson Ansley, T. A. Heller, Edward B. Vreeland, A. H. Khrieger, J. G. Fitts, A. W. Ferrin, W. T. Fish, H. O. Wait, R. J. McKay, of Salamanca; D. H. Patterson, of Great Valley; E. C. Somborger, of Buffalo, and S. F. Burger and M. Oaks, of Cattaraugus.

AFFAIRS OF THE COMPANIES.

The H. E. Swift Manufacturing Company has declared a five per cent. semi-annual dividend payable at the office of the treasurer, 34 Oliver street, Boston.

Holyoke, Mass.—The Holyoke Street Railway Company, in order to equip its lines with the electric system, has voted to increase its capital stock from $50,000 to $150,000.

Election of Officers.—The annual meeting for the election of directors of the Sandy Hill (N. Y.) Electric Light and Power Company is called for Jan. 14, 7 P. M., at the office of the company.

Sandy Hill, N. Y.—The Glens Falls, Sandy Hill & Fort Edward Street Railroad Company has voted to ask the permission of the State Board of Railroad Commissioners to increase the capital stock from $70.000 to $120,000.

Plainfield, N. J.—The Plainfield Gas and Electric Light Company organized on Tuesday of last week by the election of the following officers: President, E. R. Pope; secretary and treasurer, H. G. Runkle; directors. William Runkle, H. G. Runkle and E. R. Pope. This new company has leased the entire plant of the Plainfield Gaslight Company, and has purchased outright the Plainfield Electric Light Company's works. The company promises a better service and a material decrease in the cost of illumination to consumers.

The Connecticut Telegraph Company, of New Haven, makes the following report for Jan. 1, 1891:

Assets—Connecticut Telegraph plant	$33,274.55
Meriden fire plant	1,675.00
Fishers Island plant	2,544 00
Total construction	$37,493.55
Cash	185.76
Bills receivable	1,156.72
Total	$38,836.03
Bills payable	2,000.00
Capital stock	35,000.00
Total	$37,000.00
Surplus	1.836.03

Net earnings for the past year were about $4,000, from which an eight per cent. dividend was paid. Mr. E. B. Baker is the general manager of this company.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-177 Times Building, New York, Jan. 5, 1891.

Mr. Robert Watson, representing the Elektron Manufacturing Company, Brooklyn, N. Y., was a welcome visitor in Baltimore this week.

Mr. H. W. Shurtz and **Mr. Edward Cannon,** of the firm of Shurtz, Tobin & Cannon, manufacturers' agents, Portland, Ore., are visiting New York and Boston, and closing arrangements for handling specialties now manufactured by several Eastern companies.

The Electric Engineering and Supply Company, of Syracuse, N. Y., of which Mr. F. H. Leonard, Jr., is vice-president and general manager, will soon occupy a new factory where it will produce a full line of electrical supplies for street railways and for electric lighting purposes. This company also does considerable business in the repair of dynamos and motors. Under Mr. Leonard's management the company has attained a prominent position and is doing a prosperous business.

John Robertson & Co., of 131 Water street, this city, manufacturers of hydraulic presses, have just shipped one of their 800-ton presses to Newton Heath, Manchester, England. This machine includes Mr. Robertson's patent attachments for covering wires and cables of any thickness or diameter with lead or alloys. This firm, under the name of Robertson's Lead Incasing Works, has three of these presses in constant use, covering wires and cables with lead or alloys for wire and cable manufacturers. The press which was sent to England weighed 39,760 pounds complete.

The Garvin Machine Company, Laight and Canal streets, New York, is supplying its numerous friends with some neat inserts for the handsome paper weight and calendar sent out a year ago. In addition to the monthly calendar, each insert contains an illustration of some of the special machines which are manufactured by this firm for electrical companies, especially the screw machines, gang drills, vertical and automatic tappers, etc. The line of machinists' tools is one of the most complete ever carried in this country, both as regards the company's own manufacture as well as those of other makes.

Rawhide Gears.—The new process rawhide which is said to be distinctly different from other rawhide material used for gears, and which is manufactured by the new Process Rawhide Company, of Syracuse, N. Y., is giving good satisfaction to those who are using it. Mr. Thos. G. Fitch, general manager of the Wichita (Kan.) Electric Railway Company, says of it: "Replying to your favor of Dec. 6 will state we have used your rawhide pinions off and on since last May, together with various other kinds of pinions. We believe that your rawhide pinions are the best on the market at the present time. The first one we put on in May, 1890; this pinion was in service seven months, and was not then entirely worn out."

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 8, Cook Building, cor. Franklin and Congress Sts.
Boston, Jan. 3, 1891.

Mr. John Muir, general manager of the Railway Department of the Edison General Electric Company, was in the city for a day or two this week.

New Haven, Conn.—The Audubon Machine Works are installing a 75-light Dennison dynamo for lighting the offices of the Winchester Repeating Arms Company.

Mr. J. J. Gates, general manager of the Perkins Lamp Company, has been very sick at the Sherman House, Chicago. At last accounts Mr. Gates was on the road to recovery, and his many friends trust that his return to good health will be speedy.

Will Not Move at Once.—A Providence, R. I., dispatch says: "The rumor that the Armington & Sims Engine Company of this city was about to move its plant to St. Louis appears to have an unauthentic origin. Mr. Sims has just returned from St. Louis, where he has been looking up a site. He is satisfied with the Western city, and considers it more suitable than New England for his industry. He is quite enthusiastic about the advantages for securing material for the iron business in St. Louis, and also the business enterprise of the people of that section, but on account of the unsettled state of the money market will not be likely to take active steps at once."

Malden, Mass.—The Bell Rock Electrical Conductor Company has been incorporated with a capital stock of $500,000; par value $100 per share. A factory has already been purchased at Maplewood, Mass., and the company will cover copper wire with an insulating material, which besides having the ordinary insulation will have an extra insulation of lead. This covering will be manufactured under patents granted to Chas. O. Goodwin, now owned by this company. The covering will be put on with hydraulic pressure. The officers of the company are Adam Cook, president: Dr. Nutter, vice-president; L. J. Rodier, treasurer; Mr. Freeman, of Maine, secretary. The factory will be under the immediate supervision of Mr. J. J. Mahoney or Mr. Badger, either of whom from their past business experience ought to make a big success of the company. L. H. H.

PHILADELPHIA NOTES.

Branch Office of The Electrical World,
31 City Building, Philadelphia, Jan. 3, 1891.

The McLaughlin Electric Company is about to reorganize and the stock will be controlled by New York capitalists.

A bill has passed the common council allowing the Diamond Electric Company the privilege of furnishing electric lights, heat and power in the 28th and 32d wards. A plant will be built at once and located in the centre of the district. The company has adopted the use of the McLaughlin heater.

A Superintendent Appreciated.—The employés of the Reading Electric Light and Power Company last week presented Superintendent Arthur Arrowsmith with a handsome gold-headed ebony cane as a Christmas present. Mayor Thomas P. Merritt made the presentation speech. On New Year's afternoon Mr. Arrowsmith gave his employés a banquet, which proved a very pleasant affair.

The Electric Wire Injunction.—On motion of lawyers Alexander and Magill this week, Judge Gordon continued the preliminary injunction which was granted on the 26th inst., restraining the city of Philadelphia and its officers and agents from cutting or in any way interfering with the wires or other property of the Electric Power Company. The injunction is continued until further order of the court.

Mr. H. T. Paiste, manufacturer of electrical specialties, has issued a neat calendar for 1891. Preceding each month are six lines of poetry calling attention to the qualities and uses of the various Paiste specialties. The rhymes were written by Mr. Paiste's personal friends, prizes having been offered for the same. On the back of the calendar is printed an illustrated description of the various specialties that this firm manufactures.

Philadelphia Lighting for 1891.—The contracts for 1891, as awarded by Director Wagner, are as follows: Brush Electric Light Company, on Broad street, from Market to South, 40 cents per lamp per night; west of Broad street, Washington avenue to Callowhill, 42½ cents; west of Broad street, south of Washington avenue, 50 cents; Market street to South, east of Eighth, 42½ cents. Southern Electric Light Company, on Broad street below South, 30 cents; south of South street and east of Broad street, 30 cents. Philadelphia Electric Light Company, Broad street north from Callowhill, 40 cents; Diamond street west of Broad, 40 cents; Spring Garden street east of Broad, 40 cents; Spring Garden street, Broad to Twenty-fifth, to Green, to Broad, 40 cents, and west of Broad, north of Callowhill, 42½ cents. Northern Electric Light Company, between Poplar and Dauphin streets, Broad street and the Delaware River, 45 cents; between Dauphin street and Erie avenue, 47 cents. United States Electric Light Company, Market to Poplar streets, Delaware River to Eighth, 42½ cents. Electric Power Company, Eighth street to Broad, Vine to South, 32½ cents. Wissahickon Electric Light Company, Manayunk, Roxborough, and Falls of Schuylkill, 55 cents. Germantown Electric Light Company, Germantown, 55 cents. Frankford Electric Light Company, Frankford, south of Bridge street, 55 cents. Suburban Electric Light Company, Tacony, 55 cents. Powelton Electric Light Company, West Philadelphia, 47 cents. Four of the companies which received contracts have as yet no facilities for carrying their wires through the streets, but under an ordinance of Councils they can erect poles for this purpose. These poles must be removed upon the expiration of contracts, and cannot be used for private business. The Electric Power Company has no authority from City Councils yet to occupy the streets in any manner, although it has the contract for the central portion of the city. The Brush Company was also a bidder for this territory, which it now serves, at 42½ cents per lamp per night, but was underbid 10 cents. The Brush Company charges from 45 to 52½ cents this year. Gen. Wagner told the successful bidders that they must be ready to begin their contracts on Jan. 1 or they would forfeit the money already paid in and the city would sue for the difference between their bids and those of the next highest bidder. W. F. H.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, Jan. 3, 1891.

Stevens Point, Wis., is to be lighted by electricity.

Marshfield, Ore.—A company is being organized in Marshfield to put in an electric light plant on Coos Bay.

Columbus, O.—The clerk of the board of public works has been instructed by the board to advertise for sealed proposals for

the lighting of the city for five years. This will call for 800 or more electric lights of the same power as those now in use in that city.

The Standard Electrical Works, of Cincinnati, O., have recently issued a new and handsome catalogue of their numerous specialties.

Mr. La Fayette Cole, representing Holmes, Booth & Haydens of New York, spent a few days in Chicago recently securing business for the New Year.

The Chicago office of the United States Electric Lighting Company has been removed from the ground floor of the Rookery Building to larger quarters on the ninth floor.

The Chicago Electric Club entertained its members and their friends with a very enjoyable social and dancing reception on Dec. 26. The intention of the committee having these entertainments in charge is to furnish a series of four of these "socials" during the winter, thus materially promoting the social standing of the club.

Warsaw, Ind.—The board of trustees of Warsaw has made a contract with the Warsaw Electric Light and Power Company by which the village agrees to pay to the company $65 a year per light for 25 arc lights of 2,000 c. p. standard for the term of five years. The company is to have the lights in running order on or before May 1, 1891.

Seattle, Wash.—The Home Electric Company has recently received ten car loads of new machinery, including six boilers, two dynamos and a quantity of wire and other material. The machinery is being fitted up at the new power house, which will be finished about Jan. 15. The company has sold 15 small motors for printing offices, elevators and other purposes.

Mr. Henry Hutton, late of Baltimore, Md., recently removed to Tacoma, Wash., where he will continue his business as a contract ng and consulting electrical engineer. Mr. Hutton has had a number of years experience in this line and has at different times represented several large electrical companies in the United States and South America. It is his intention to carry sufficient stock of engines, dynamos, motors, wire, etc., to enable him to erect complete electrical plants for light or power. He will also act as manufacturers' agent for articles in his line, and it will, no doubt, be to the advantage of manufacturers to open a correspondence with him. H. C. E.

SOUTHERN NOTES.

NORFOLK, Va., Jan. 3, 1891.

Austin, Tex.—The Shipe Electric Railway is nearing com pletion.

Covington, Ga.—A company is organizing to build an electric line to Porterdale.

Lampasas, Tex.—The new electric light plant will in a few days be in operation.

Brunswick, Ga.—An electric light plant has been placed in the Oglethorpe Hotel.

Dayton, Tex.—The city council is negotiating for the erection of an electric lighting plant.

Ft. Worth, Tex.—John C. Ryan and others will build an electric railway to Prospect Heights.

Little Rock, Ark.—The city is preparing to increase the capacity of its electric light plant.

Mineral Wells, Tex.—An electric light plant is to be established by parties from California.

Wilson, N. C.—The city council will issue $15,000 of bonds for the erection of an electric light plant.

Madisonville, Ky.—The city council is obtaining estimates for the erection of an electric light plant.

Athens, Tenn.—The Athens Woolen Mill Company will put in an isolated incandescent electric light system.

Denton, Tex.—Operations have commenced on the new electric light plant, which is being erected by the city.

Norfolk, Va.—New machinery is being added to the electric light plant of the Norfolk City Gaslight Company.

Honey Grove, Tex.—Projects are on foot for the establishment of an electric line and a telephone exchange.

Comanche, Tex.—The city council has voted to pay $500 a year for twenty 10 c. p. incandescent electric lights.

Wheeling, W. Va.—F. Barrett and others are organizing a $50,000 company to establish an electric power plant.

Galveston, Tex.—An electric power plant 120 × 81 feet is to be erected by the Galveston City Street Railway Company.

Wheeling, W. Va.—An isolated incandescent electric light system is to be installed in the Mt. De Chantal Academy.

Raleigh, N. C.—The city council has contracted with the Sun Vapor Street Lighting Company, of Canton, O., for 60 lights.

Waco, Tex.—It is stated that the Boston-Waco Land Company will construct and operate an electric line 2½ miles long to Mt. Lynn.

Raleigh, N. C.—The Edison Electric Company has received the contract for the changing of the Raleigh Street Railway to an electric line.

Ft. Worth, Tex.—The finishing touches are being put upon the city's electric light system, and it will be in operation within a few days.

Corpus Christi, Tex.—Additional machinery will be added to the electric light plant of the Corpus Christi Electric Light Company.

Grafton, W. Va.—The capacity of the plant owned and operated by the Grafton Electric Light, Heat and Power Company will be enlarged.

Athens, Ga.—An isolated incandescent electric light system has been installed in the cotton factory of the Athens Manufacturing Company.

Johnson City, Tenn.—It is stated that an electric line is in process of construction by the Johnson City & Caregie Street Railway Company.

Fort Worth, Tex.—Considerable stock has already been taken in the company which proposes to build an electric line to Brooklyn Heights.

Columbia, S. C.—The Columbia Electric Street and Suburban Railway and Electric Car Company has petitioned the State legislature for a charter.

Buena Vista, Va.—Mr. Eugene R. Carishaff will be the electrician in charge of the construction and equipment of the Buena Vista Electric Street Railway.

Oxford, Ala.—The Oxford Lake line will issue $75,000 of bonds with a view to converting its line into an electrical road and extending it through Anniston.

Athens, Ga.—The construction of the new electric line has commenced. The apparatus has been purchased, and the line will be in operation in a month or so.

Clifton Forge, Va.—A $25,000 stock company is being organized by George Swan, R. J. James, E. G. Roberts and others to establish an electric light plant.

Americus, Ga.—A temporary discontinuance of the Americus electric line is contemplated on account of the Alabama strikes, which render it difficult to get coal.

Chester, S. C.—An isolated incandescent system, consisting of 200 electric lights, has recently been installed in the cotton mills of the Chester Manufacturing Company.

Greenwood, Miss.—The city council has contracted with the Sun Vapor Street Lighting Company, of Canton, O., for 40 street lamps, the contract to run three years.

Chattanooga, Tenn.—An electric light plant, both arc and incandescent, will be installed in the machine shops of the Nashville, Chattanooga and St. Louis Railway Company.

Front Royal, Va.—The Maryland Tack and Wire Nail Company is obtaining estimates looking to the installation of an isolated incandescent electric light system in their factory.

Abilene, Tex.—The electric light company recently formed by R. W. Kindel, J. S. Massie, John Honey and others, is reported to have awarded the contract for the erection of its plant.

Harrisonburg, Va.—The Harrisonburg Electric Light Company has been organized to erect and operate an electric light plant. J. P. Honek is president and E. S. Conrad secretary.

Newbury, Miss.—The New York Contract Company has made the City Council a proposition looking to the erection of an electric light plant and the establishment of a system of water-works.

Charleston, W. Va.—The New York & Ohio Company has been incorporated by M. B. Rever, J. C. Neal and others for the purpose of manufacturing electrical supplies and other machinery.

Darlington, S. C.—The Darlington Light, Water and Power Company, recently reported incorporated, has perfected its final organization and will at once proceed to the establishment of its plant.

Reidsville, N. C.—The City Council, having recently purchased the electric light plant of the Reidsville Electric Light and Power Company, is preparing to put in additional machinery and operate the same.

Charlottesville, Va.—E. R. Polehampton has opened an electrical supply house for the putting in of electric bells, calls, house and hotel annunciators, electric gas lighters, and for the execution of all kinds of electrical work.

Honey Grove, Tex.—The Honey Grove Ice and Electric Company, with a capital stock of $25,000, has been incorporated by W. D. Wilkins, C N. Kinney, J. A. Pierce and others, and will establish an electric light plant and other improvements.

Newbury, S. C.—The City Council is negotiating for the establishment of an electric light plant. Mr. L. N. Cox, of Washington, D. C., offered to put up 80 incandescent lights at $25 per light, making it cost the city $2,000 a year. This proposition is now being considered by the council.

Chattanooga, Tenn.—The failure of the Hughes Lumber Company, it is stated, will not affect the Chattanooga Electric Light and Power Company. D. W. Hughes, the president and general manager of the lumber company, is the largest stockholder of the electric light company.

Anniston, Ala.—Contracts have been awarded for the erection of a bee hive plant, a building in which a number of small enterprises will be located. The power will be furnished by electricity. The dimensions of the building are 100 × 70 feet, 3 stories in height. The same plant will also furnish electric lights throughout the building.

Richmond, Va.—A special meeting of the committee on electric light was held recently for the purpose of signing the contract of the Richmond Electric and Railway Company for furnishing 134 street lights for one year from Feb. 8 next. The company had a contract in readiness the same as the one under which the lighting is now done, but the committee did not think it proper to sign until the city attorney had seen the contract, and after a lengthy and spirited debate it was referred to that official.

Falls Church, Va.—A company has been organized for the purpose of putting in an electric light plant large enough to supply the stores and dwellings with light and for street lighting purposes. The officers of the company are: Edwin A. Breenough, president, and T. R. Gordon, secretary and manager. The contract has already been given it is stated to the Edison Electric Illuminating Company for 300 incandescent lamps and a number of arc lights, and will cost $10,000, all the necessary capital for which has been subscribed.

Columbia, Mo.—A restraining writ has been filed against the local board of trustees proceeding with the construction of the electric light plant and water-works. The people by a four-fifths majority recently voted in favor of issuing $45,000 in bonds for the establishing of these plants, and a board under this vote awarded a contract for the construction of the two enterprises. The petition for the injunction alleges that under the statutes of the State the town of Columbia has no power to own and operate the proposed plant, and that even if it had there were irregularities in the election which make the issue of bonds illegal.

Rockville, Md.—The Edison Electric Light Company has refused to ratify the contract made by their agent with the town council a week ago. By the terms of that agreement the corporate authorities had agreed to pay the sum of $25 per light for one year, the company to put the plant within the corporate limits and furnish iron posts for the wires on the main street and wooden ones on the cross streets; the corporation to start with 10 lights and have the privilege of any additional number at the same price. A representative of the Edison Company was present at a recent meeting of the council, and offered to enter into another contract, whereby the corporation should pay $40 per light instead of $25, and wood instead of iron parts should be used. This proposition the council promptly refused. It is stated that an effort will be made at once to organize a company for the purpose of establishing a plant. V. N. B.

WASHINGTON, D. C., Jan. 3, 1891.

Another Electric Tabulating Machine.—Intimation has been received here that a machine has been made in Austria which is described to be similar to the electric tabulating machine now in use in the census office, and invented by Mr. Hollerith. The statement is to the effect that the machine will be used in tabulating census statistics of Austria, which are about to be collected.

A Novel Electric Light Display at the White House.—For several days past the work of establishing the electric lighting system at the White House had been pushed vigorously in order that the lights might be ready for use during the President's New Year's reception should it be dark enough to require artificial illumination in the parlors. The design for the red room is thoroughly unique. The great chandelier hanging from the centre of the room has been removed and in its stead there are four pendant rods, one from each corner of the ceiling at the distance of about six feet from the walls. These rods, coming much nearer to the floor than the ordinary fixture, have a gold finish and at the end bear four lamps each. The design for the rods, which are handsomely turned and gracefully twisted, was made by the Edison Company. Side fixtures holding three lamps apiece are placed on the east wall on either side of the portrait of Mr. Arthur, which they are designed to illuminate. The current was turned on the lamps in the east room for the first time last Tuesday, and as a result everybody is highly pleased with the effect that has been produced. Each chandelier contains a system of lamps, while the ceiling glows with the light of 112 lamps concealed above 12 glass "suns." There are four in each section of the room, those in the north and south sections containing 12 lamps each, while those in the centre hold but four. There will be four more of these small "suns" placed in the centre section. A very handsome electrolier has been designed for the private dining room. It is of a beautiful model, slender and graceful, the main motive being a small cherub holding to a rod coming down from the ceiling with one hand, and swinging the lamp rods in the other. The same motive is utilized in the design for the side lights. In the blue and green rooms, the corridor and the foyer, an effort has been made with marked success to harmonize the old chandeliers with the altered surroundings in substituting the incandescent lamps for gas. The state dining room will not be fitted until next year. E. A. O.

ENGLISH NOTES.

LONDON, Dec. 24, 1890.

The Expiration of the Telephone Patents.—The National Telephone Company continues to be threatened in all directions with competitors, and the Postmaster General, in his usual oracular manner, hints vaguely at possible Post Office competition when the transmitter patent expires next July. Meanwhile wholesale reductions of rentals continue to be made in the provinces by the National Company. The London subscription, which now stands at £20, is to be maintained, but we are promised—though with what likelihood of fulfillment I am unable to ascertain—complete metallic circuits.

Electric Tanning.—I note that a company has just been organized for the purpose of introducing into the United States the Worms and Balé system of tanning. At the present moment there is a law suit pending between Mr. Groth and the British Tanning Company, which works the Worms and Balé process. Mr. Groth has patented a method of tanning by electricity, which, while strikingly similar to that of M M. Worms and Balé, is, he claims, superior. The respective merits of the two processes can only be settled by the tanners, but the respective values of the two patents will probably be decided within the next few weeks in the law courts.

Telegraphy and Politics.—In connection with the figures which I gave you in a previous letter with regard to the number of words dispatched by telegraph during some recent political meetings at Newcastle, it may be interesting to recall the fact that on the occasion of Mr. Gladstone's introduction, early in 1886, of the Home Rule Bill, no less than 1½ million words were dispatched from the central telegraph office between 4 P. M. and 3 A. M., over 400 operators being employed to cope with this flow of eloquence. No doubt to the telegraph operator the degree of political excitement on any occasion is prosaically estimated by the number of extra "Wheatstones" and extra clerks which it entails.

Meeting of the Physical Society.—The meeting of the Physical Society last Friday was one of exceptional interest. Mr. Shelford Bidwell, who is one of the earliest experimenters with selenium, exhibited some striking experiments with selenium cells. The second paper was by Mr. Swinburne, and described some condensers, which he has been making suitable for use with alternating currents. Condensers have hitherto been rarely used in electrical engineering, except for submarine telegraphy; but Mr. Swinburne's condensers are designed to permit a fluctuating current of no less than one ampère to pass under 2,000 volts pressure. He has been troubled by the heating, and has offered various suggestions, but it is doubtful whether this is due to want of homogeneity in the dielectric, or to the absence of perfect elasticity. One form of condenser which does not heat makes such a noise that it is impossible to hold a conversation in the same room with it. In the discussion which followed the paper, the peculiar effect which is observed on the Ferarnti mains was dealt with by several speakers, including Sir William Thomson. It is found that with a transformer *between the dynamo and the mains at Deptford*, the capacity of the line has an effect upon the transformer, which practically alters its ratio of transformation, and the pressure at London is apparently higher than at Deptford. In one case while 280 h. p. was being transmitted, the pressure at Deptford was 8,500 volts, while at London, seven miles off it was 10,000 volts. When the dynamo at Deptford feeds direct into the mains, the transformers being (as it would be in ordinary working) at London, no such phenomenon is observed.

The Chelsea Electricity Supply Company and Its Customers.—Attention was called, as mentioned last week, by a letter of Messrs. Mappin Brothers to the *Times* to the inconvenience caused by the successive breakdowns in the supply furnished by the London Electric Supply Corporation. A day or two afterwards Mr. Richard Chamberlain, who with a voltmeter which, like Cæsar's wife, is apparently above suspicion, has for some twelve months past been a thorn in the side of the Chelsea Electricity Supply Company, asked the President of the Board of Trade in the House of Commons whether he could not bring the Chelsea Company to a proper sense of its duties. According to Mr. Richard Chamberlain, the Chelsea Company takes advantage of the Board of Trade regulation that the voltage at the consumer's terminals may vary four per cent. in either direction, to persistently keep it at about 97 instead of the standard pressure of 100 volts. Mr. Chamberlain received small comfort, however, from the president of the board, who said that as long as the voltage did not vary more than the legal amount there was no remedy against the company. The variation allowed by the Board of Trade is no doubt excessive, in view of the fact that a variation of a few volts on either side may make a vast difference in the light furnished by an incandescent lamp. But no company consulting its own interests would do as Mr. Chamberlain asserts that the Chelsea Company does, namely, keep the voltage at the lowest allowable amount. The conclusion one must come to in view of the fact that no other complaint has

ever been made against this company is that Mr, Chamberlain must either be particularly exacting, or his voltmeter must be at fault.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Book on Dynamos and Motors.—Will you please inform me through your columns where I can find a good explanation of the fundamental principles of dynamos and motors, together with an explanation of electrical terms? AMATEUR.

Fleming's "Short Lectures to Electrical Artisans" is the book which will give you precisely the information you desire. It can be furnished through this office.

Book on Secondary Batteries.—Can you inform me through your columns what book will give me practical information on the building of secondary batteries? T. L.

There is no workshop treatise on the manufacture of secondary batteries. Many excellent pointers can be obtained from Reynier's "Voltaic Accumulator"; and such other information as is published is, for the most part, scattered through the files of technical journals.

Incandescents on Arc Light Circuits.—Will you be kind enough to answer the following questions? (1) The Brush Company has a system of incandescent lighting which takes its current from the arc circuit. Said company refers to this as its "multiple series system." Houston's Dictionary Appendix calls this system of wiring "series multiple." Which is the correct term? (2) A Brush alternator is said to have burst apart when running at high speed in some town in Michigan some time ago. Can you give me details of the accident? F. K. H.

(1) Either term is correct. Of the two the latter is more frequently used. (2) We have no details of the place or character of the accident you refer to.

Various Queries.—(1) Can you inform me through the columns of your paper where I can get specifications for dynamos, or motors that have a permanent armature, or very little moving wire? (2) How can I charge a Gassner dry battery? (3) To whom can I send to get the latest improved writing telegraph? (4) How perfect synchronism is obtained in the latest apparatus for synchronous telegraphy? R. W. S.

(1) Consult the Patent Office *Gazette* to find what you desire, and the specifications can then be obtained direct, or through the patent department of THE ELECTRICAL WORLD. (2) Would not recommend trying to recharge a dry battery, unless you have the formula which is used by the makers, as the operation requires some care. (3) Consult the advertising columns of THE ELECTRICAL WORLD. An article on the writing telegraph was published some weeks since. (4) The synchronism obtained is excellent in several of the recent systems, so good as to leave little to be desired, when the apparatus is in first rate working order.

Commutator for Motor on Arc Circuits.—Will you kindly inform me, through the columns of THE ELECTRICAL WORLD, (1) How to construct a commutator and brushes for a small motor to use on a 10-ampère arc circuit to avoid excessive sparking? (2) The best method of inserting a small motor into such a circuit? (3) What are the best elements to be used in constructing a commutator for such a motor, and what sized wire should be used? O. R. C.

(1) Have a cylinder of gun metal cast; bore through its centre a hole a little larger than needed to accommodate the shaft; turn down the outside to the size you want, leaving a projecting flange at one end for connection of wires; bevel off both ends of the cylinder so that the retaining rings which hold the commutator in its place will have a proper bearing; then with a saw, preferably one of the saws used in a milling machine, saw up the hollow cylinder into the number of segments you require. (2) A motor is put into an arc circuit exactly as an arc lamp would be. All such motors are series wound, and the size of wire to be used depends on the current the machine is intended to carry. For a 10-ampère current 12 or 13 B. W. G. wire is sufficient for the fields; in the armature, the two sides of it being in parallel, No. 16 will do. (3) Hard copper or gun metal, with mica insulation.

Rules for Wiring.—For incandescent wiring the following rule is frequently used, and in ordinary practice gives correct results for safe carrying capacity of the wires. The rule is as follows: Per cent. loss

$$\frac{\text{Per cent. loss}}{2d \times n} \times 1{,}000 = \text{permissible resistance for 1,000 feet of the}$$

conductor required; where $2d$ equals twice the distance of the lamp, the number of ampères, and per cent. of loss the drop of potential in volts. Why will not this rule hold for the following example, and will you not give a rule that will hold good? One thousand lamps at one ampère per lamp, 10 feet away, 10 per cent. drop, what size should be the wire? Please explain the mistake in the rule. SUBSCRIBER.

There is no mistake in the rule as given, but like every other ordinary rule involving resistance it assumes the resistance to be constant, and consequently will not hold when the current density is so great as to heat the wire. The amount of heat of course involves an unknown quantity. The rule itself is derived, as you can readily see, by removing the $2d$ from the denominator, from Ohm's law, connecting the current with the fall in potential; the numerator of the fraction should be in every case the loss of potential in volts, and not the percentage of loss, unless the original potential chances to be 100 volts. There is no simple rule that will enable you to calculate an extreme case such as that which you give. To do it you would be obliged to introduce the question of heating, which would necessarily have a form too complicated for everyday use. Further, the example is an absurd one on its face, as 10 per cent. drop at the given distance is worse than an absurdity—it approximates being idiotic. For very heavy currents, where single wires or bars are used, 1,000 ampères per square inch of section is a good rule.

News of the Week.

THE TELEPHONE.

Harrisburg, Pa.—The Long Distance Telephone Company has reached Harrisburg with its lines.

The Hudson River Telephone Company, at Albany, N. Y., has decided to again take charge of the outlying lines which it leased to other companies several years ago. The leases are now running out. New double metallic circuits and new instruments will be put in as fast as possible.

The New Exchange Building at Albany, N. Y.—Manager Uline, of the Hudson River Telephone Company, has completed the purchase of the premises on the northeast corner of Chapel street and Maiden lane for the new telephone exchange by paying the sum of $9,000 therefor and receiving a deed for the property.

Taunton, Mass.—The Long Distance Telephone Company put up poles on Whittenton street a short time ago, but the owners of the property wanted damages, and, under permission of the city, the poles were changed to Jackson street. A petition from seven residents of that street went to the aldermen, and two secret sessions of the board were held to consider the matter, when the petitioners were awarded $50 per pole, or $350, while each member of the board of aldermen was declared entitled to $28 for services from the company, making a total of $574 for the privilege of erecting seven poles on a public street.

Bell Telephone Statistics.—The statement of the output of telephones by the American Bell Company for the month and year ended Dec. 20 is as follows:

December.	1890.	1889.	
Gross output	5,542	5,010	Inc. 532
Returned	3,171	2,140	Inc. 1,031
Net output	2,371	2,870	Dec. 499
Jan. 21 to Dec. 20.			
Gross output	64,647	57,167	Inc 7,480
Returned	27,878	24,967	Inc. 2,911
Net output	36,769	32,200	Inc. 4,569

The following is a comparison of the movement of telephones by months, and also for the last five years:

	Gross output.	Returned.	Net output.
January	3,452	2,241	1,101
February	4,298	2,261	2,037
March	5,179	1,648	3,531
April	6,062	1,892	4,170
May	6,938	2,135	4,803
June	7,758	1,927	5,831
July	4,787	2,887	1,900
August	4,322	2,761	1,561
September	5,723	2,358	3,365
October	5,378	2,205	3,173
November	5,313	2,392	2,926
December	5,542	3,171	2,371
Year 1890	64,647	27,878	36,769
1889	57,167	24,967	32,200
1888	53,609	23,601	30,008
1887	52,156	26,789	25,367
1886	42,306	19,924	22,382

THE ELECTRIC LIGHT.

Spencer, Ia., is putting in an electric light plant.

New London, Wis., wants an electric light plant.

South Chicago, Ill.—The Calumet Gas and Electric Light Company's building was burned on the morning of Dec. 31. The loss is reported as about $30,000.

Gibson, Ill., wants electric lights. A local company will probably be organized. The town agrees to take 40 thirty-two candle power lights at $1 per month each.

Youngstown, O.—An arc light plant and an incandescent light plant are to be put in the Brier Hill Iron and Coal Company's establishment and a 15-light arc plant is to be erected at the Youngstown Steel Company's plant.

Fairbury, Ill.—The Board of Aldermen has made a contract with H. A. Foster & Co. to furnish Fairbury with electric light for five years. The company is to use arc lights on the streets in the business portion of the town and incandescent lights throughout the residence part.

Windsor, Ont.—The proposition of the Reliance Electric Lighting Company to erect a $15,000 incandescent plant, if it is allowed to string its wires on the town poles, has been accepted by the council. The Reliance Company will pay five per cent. of the cost of the town poles for this privilege.

Beaver, Pa.—A company composed of J. F. Reed, Dr. G. A. Scraggs, S. H. Darragh, A. T. Anderson and J. J. Davidson, of Beaver, propose to establish an electric light plant here to furnish arc lights for the streets and business houses. They are now canvassing for business, and if 50 lights can be procured in the contiguous boroughs the plant will be established.

Lima, O.—The Lima Electric Light and Power Company is putting in a 1,500-light Westinghouse alternator to furnish lights for South Lima, a distance of from one to two miles from the central station. The company has also added four 100 h. p. boilers. This gives a total capacity of 800 h. p. The machines now running are six Thomson-Houston arcs, two Thomson-Houston and one Westinghouse alternator, one railway generator of 65 h. p. and two Thomson-Houston incandescent machines.

Burlington, Vt.—An electric company, known as the Vermont Electric Company, has just been organized in this city. The charter secured by the incorporators is an unusual one, and met with great opposition in the State legislature. It has valuable privileges, under which the company will soon begin to operate. One of these is the development of the property known as the gorge near the twin railroad bridges, just above Winooski village, and the transmission electrically of this immense water power to Burlington to be used in driving all kinds of machinery. It has been voted to increase the capital stock to $100,000.

Electric Light in Photography.—Francis A. Cameron, a New York photographer, in speaking of this application of the electric light says: "It is now used in lighting studios and for securing artistic effects of light and shade. In order to avoid black, hard shadows, the light is projected onto a sheet of alabaster and thence on the subject. The result is soft and exquisite in tone. The electric light is also used for printing, for enlargement, and for balloon and kite photography. In aerial photography the camera is attached to a kite. When the desired height has been reached the exposure is made by electricity, and pictures are thus secured which it would be impossible to obtain by any other means."

Lighting Business of the Westinghouse Company in 1890.—The Westinghouse Electric and Manufacturing Company has just completed the most successful year in the history of the organization. According to the report of shipments made up to Dec. 31, 1890, the company shipped 217 alternating current incandescent dynamos of a capacity aggregating 248,150 sixteen c. p. lights during that year. This makes a total of 730 alternating current incandescent light machines, with a total capacity of 720,800 sixteen c. p lamps, which have been shipped by the company since its organization in November, 1886. During the first year, *i. e.*, 1886, the shipments amounted to alternating current apparatus aggregating 2,453 sixteen c. p. lamps; during 1887 they were 106,200 lights; during 1888, 119,950; during 1889, 228,150, and during last year 248,850 incandescent lights. The figures show that the year just closed has been the most prosperous the company has ever had, and the record also shows that the reputation of the apparatus manufactured by the Westinghouse Company is constantly increasing. The company commenced the manufacture of alternating current arc light apparatus during the last year. The first shipment of these machines was made in January, 1890. Since that time the company has shipped 107 alternating current arc light dynamos aggregating a capacity of 5,680 2,000 c. p. lamps. The Shallenberger alternating current meter and the converters utilized in connection with the Westinghouse system of alternating current electric lighting are well known all over the globe. Over 20,000 Shallenberger meters and more than 30,000 converters are now in use. During the month of December the company received orders to increase the capacity of seven central station plants where its alternating current system is already in operation, and, in addition, a number of new contracts were obtained for the installation of incandescent as well as arc light apparatus. Among the latest orders are: An increase of 750 lights for Olean, N. Y.; 3,000 lights for St. Louis, Mo.; 1,500 lights for Keokuk, Ia.; 3,000 lights for Louisville, Ky.; 500 for Wilmerding, Pa.; 750 for Mansfield, Pa.; 750 for Albion, N. Y.; 750 for Berlin Falls, N. H.; 750 lights for Windsor Locks, Conn., and 500 for White Water, Wis.

THE ELECTRIC RAILWAY.

St. Louis, Mo.—The Southern or Sixth street car line of St. Louis is now an electric road, the first motor car traveling over the road last week.

Leadville, Col.—Col. R. E. Goodell and Dr. John Law will, on behalf of a company they represent, petition for right of way through the city for an electric street railway.

The Terre Haute (Ind.) street railway commenced the operation of its electric line as a New Year's gift to the patrons. The road is equipped with the Westinghouse system.

Lockport, N. Y.—The Lockport Street Railway Company has decided to substitute the electric system of propulsion for horses, and give the public a real system of rapid transit. The overhead system will be used.

An Elevated Electric Railway.—An ordinance has been introduced in select council of Philadelphia authorizing the construction of a double track electric elevated railway on Ridge avenue, Arch and other streets.

Sandy Hill, N. Y.—The Glens Falls, Sandy Hill and Fort Edward Street Railroad Company has elected the following directors and officers: Directors—J. M. Coolidge, B. B. Fowler, H. R. Leavens, Glens Falls; W. H. Rowe, Troy; Samuel Bolton, Jr., Peter McCarty and J. A. Powers, Lansingburgh. President, J. M. Coolidge; secretary and treasurer, B. B. Fowler. Executive committee—J. M. Coolidge, B. B. Fowler and J. A. Powers. It has also been voted to ask the permission of the State Board of Railroad Commissioners to change the motive power to electricity.

Wilmington, Del.—Franklin B. Colton, trustee for a new syndicate of railways to be shortly established in Wilmington, has purchased from the McComb estate and others 2,201 of the 3,135 shares of stock owned by the Front Street Railway Company, for the purpose of controlling the old road and with a view of increasing the length of the route and running a first class road. It is expected that before another year the extreme eastern part of the city will be in direct communication with the extreme western portion by railways operated by electricity as the motive power.

Electric Railway for the City of Mexico.—Mr. Samuel Lesem, of Denver, Col., has just returned from the City of Mexico. He says that while there he obtained the exclusive franchise for operating electric motors in that city and for the establishment of an electric street railway system. His franchise covers 50 years all told, 12 years' exclusive privilege and 15 years free from all import duties and taxes, except stamp tax. Mr. Lesem says that this company expects to lay 250 miles of track for the street railways and that it will spend at least 15 millions in building the entire electric system in and about the City of Mexico.

Westinghouse Railway Business in 1890.—During the last year the Westinghouse Electric and Manufacturing Company added another branch to its business in the manufacture of electric street railway apparatus. In that branch the record of the shipments shows perhaps the most phenomenal growth which has ever been achieved by any concern in the electrical industry. The company did not commence to ship motors until the first of July. Since then 211 15 h. p. motors have left the shops for the equipment of 40 electric railways. This makes an average shipment of over 35 motors per month.

St. Louis, Mo., has perhaps more electric railway lines in operation than any other one city in the United States. There are four separate and distinct lines in that city equipped with the Thomson-Houston railway system, in addition to which there is one line across the suspension bridge at that place which is equipped with the same system, and a smaller line immediately across the river from St. Louis connecting with the bridge line, which is also equipped with Thomson-Houston apparatus. The total number of cars equipped with the Thomson-Houston system in St. Louis is 139; the number of motors, 278; the total horse power of which is 4,170.

GENERAL APPLICATIONS OF POWER.

Hartford, Conn.—The County Commissioners have granted the petition of the Hartford Electric Company for permission to place poles and wires along the highways in the towns of Bloomfield and Hartford for the purpose of bringing the electricity from the new works on the Farmington River to Hartford.

The Motor in the Printing Office.—The Indianapolis (Ind.) *News* is now running its presses by an electric motor made by the Jenney Company, of that city; its capacity is 20 h. p., with self-oiling bearings; it runs two perfecting presses, stereotyping machinery, two electric fans, and the ventilating apparatus. In speaking of this motor Mr. W. J. Richards, the business manager of the company, says: "The charm of its work to us is that we may have all the machinery running and suddenly cut off down to a single press without any perceptible increase of the speed of that press. Or having one press alone in operation we may add all the other machinery without perceptible diminution in the speed, which saves us many breaks in the web, with which we had considerable annoyance when using steam power.

An Electric Submarine Boat.—The Detroit Boat Company is constructing a submarine craft, which is 40 feet long, 9 feet beam, and 14 feet depth of hold. The mechanism is somewhat similar to that of the submarine torpedo boat. Electric storage batteries will be used. The improvement over the torpedo boat is claimed in the buoyancy of the craft, which will come to the surface as soon as the electric motor is stopped, whereas the machinery of the torpedo boat must be working to bring it to the surface of the water. Besides a screw wheel at the stern, there will be two wheels on either side of the new craft. Turning an electric switch

will cause the boat to rise or plunge deeper in the water. It is being built as a pleasure craft, but if it proves successful the government will be requested to consider its adoption as a torpedo boat.

LEGAL NOTES.

No Injunction Granted.—The General Term of the Supreme Court in this city has affirmed an order denying the application of the American Rapid Telegraph Company for an injunction restraining the city authorities from removing its poles and overhead wires. The company claimed that the Legislature had no right to order the removal of poles and wires, when the removal would be injurious to the company. The court decided that the Legislature has every right to free the streets of unsightly and dangerous obstacles.

Suits Against Subsidized Roads.—Messrs. Aldrich, of Illinois, and Caldwell, of Nebraska, special Assistant United States Attorneys, and General Swayne, of New York, counsel for the Western Union Telegraph Company, have been in consultation during the past week with Attorney-General Miller, at Washington, D. C., in regard to the suits instituted under the act of 1888 against the land grant subsidized railroad companies to compel them to operate their own telegraph lines. The consultation was for the purpose of securing an agreement on certain points of evidence.

The New York and Pennsylvania Telephone Company, of Erie, Pa., has begun action against the Erie Motor Company of the same city in the Court of Common Pleas. The action is for trespass and the damages are laid at $50,000. The telephone people allege that the wires of the motor company have damaged the value of their franchise, and that by induction the telephone service in Erie has been damaged to a great extent. They claim that right for damages is attached to priority privileges. The telephone company claims to have expended a large sum of money to correct the interference, but without avail.

Brush-Swan vs. Brush.—In the suit of the Brush-Swan Electric Light Company against the Brush Electric Company, which is ending in the United States Circuit Court, and in which certain patent rights are concerned, Judge Cove last week made an order permitting the defendant to make any sales of electrical machinery, apparatus and supplies in territories mentioned in a previous decree, provided it sets aside a commission of 20 per cent. on all moneys received, pending the final adjudication. This fund will be paid into the hands of the plaintiff company provided it files a bond of $25,000; otherwise it must be turned over to Commissioner Shields as registrar of the court.

Leo Daft vs. The Daft Electric Light Company.—In the Supreme Court of New York, Leo Daft has entered a summons and complaint against the Daft Electric Light Company, the United Electric Traction Company, John C. Barron, Robert C. Belknap and others, praying that the court may issue a decree declaring illegal the contract relating to the exchange of the stock of the Daft Electric Light Company for the stock of the United Electric Traction Company; that the United Electric Traction Company may be enjoined from issuing the bonds attempted to be secured by the mortgages to the Mercantile Trust Company and Chas. W. Gould, and that a receiver may be appointed to take possession of all the property of the Daft Electric Light Company.

Who Is Liable?—An interesting question of liability arises in connection with the fire and explosion which occurred in the works of the Lynn Gas and Electric Light Company, Lynn, Mass., recently. The fire started in the wire tower, and caused the short circuiting of several wires. This, the gas company claims, so accelerated the speed of the Corliss engines running the dynamos as to cause an explosion of the great fly-wheel and several smaller wheels. The gas company claims that the insurance companies are liable for the loss, as the explosion was the result of fire. The insurance companies deny liability, holding that while the explosion may have occurred as a result of fire, the simple short-circuiting of wires was not sufficient to demoralize a Corliss engine unless there was a defect in the mechanism, the result of carelessness or inattention in running the same.

PERSONALS.

Lord Rayleigh has been elected an honorary member of the Bavarian Academy of Science.

Mr. W. H. McClure has been elected by the aldermen and common council of Worcester, Mass., as city electrician.

Mr. Eugene H. Cowles, of the Cowles Electric Smelting and Aluminium Company, is reported as seriously ill at Cleveland, O.

Mr. W. Dwight Wiman, well known as the manager of the Staten Island Light, Heat and Power Company, is to deliver a lecture on Thursday, Jan. 15, at Brighton Heights, on "Electricity in Common Life."

Mr. John H. Sharpe, for some time past with the Edison Electric Illuminating Company of Brooklyn, N. Y., has been appointed general superintendent of the Nyack Electric Light and Power Company at Nyack on the Hudson, N. Y.

Mr. William Brock, general manager of the Edison Electric Illuminating Company, at Paterson, N. J., was pleasantly surprised last week and given to understand the estimation in which he is held by the employés. Just before the noon hour Wednesday they had quietly congregated in his office, and he was hastily summoned. His surprise was heightened as one of the men stepped forward, and in a few well chosen words presented Mr. Brock, in behalf of his fellow workers, with an elegant gold, watch and in behalf of Mr. William T. Ryle, president, and Mr. Arthur Ryle, treasurer of the company, with a fine gold chain and charm.

MISCELLANEOUS NOTES.

Removal of Office.—The Cowles Electric Smelting and Aluminium Company has removed its office to the works at Lockport, N. Y.

Nashville, Tenn.—The bill granting right of way to the Electric Time Company, as recommended by the Board of Public Works and Affairs, has passed second reading and has been recommitted to the board.

To Go Underground.—The finance committee of the Pittsburgh councils has recommended the appropriation of $20,000 for the purpose of placing underground the police, telephone and fire alarm wires in the heart of the city.

Electric Welding in England.—Sir Douglas Galton, Mr. W. H. Preece, Mr. Ashton (of the Royal Laboratory, Woolwich), and other gentlemen visited Messrs. Lloyd & Lloyd's Coombes Wood Tube Works recently for the purpose of inspecting their installation of electric welding. The process used is that known as the Bernardos process, the sole right to the use of which has been acquired by Messrs. Lloyd & Lloyd, and the welding is effected by means of the arc.

Good Chance for Electrical Manufacturers.—It is proposed to send from Boston on March 20 a "squadron of exposition which shall continue the fraternal work begun in Brazil by Admiral Walker's "squadron of evolution," and shall also open for American merchants and manufacturers a way into the marts of our neighbors to the south. The enterprise is that of the Three Americas Company. Four steamships are to constitute this Armada, the interior of each to be used for the display of manufactured goods, wares, merchandise, machinery, tools, inventions, etc.

Industrial and Trade Notes.

The Perkins Electric Manufacturing Company, of Hartford, Conn., is very busy with orders for its new switch.

E. L. Edes, of Plymouth, Mass., is still enjoying a large trade in the zinc line, his sales for fire alarm and battery zincs of unusually fine alloy having been larger than ever for the past year.

Bradford, Kyle & Co., of Plymouth, Mass., have just introduced to the trade a new magnet wire which is very small but strong. It has an unusually fine insulation with an adhesive sub coating which holds the insulation firmly in place and is especially adapted for use in fine testing instruments.

Sale of Insulators.—It is reported that an unexpectedly large demand has arisen for the new Bain glass and break insulators recently illustrated in these columns. The Central Electric Company has just received its first stock order of these articles, and reports that every insulator was sold before the shipment arrived.

The Shawhan Machine Works, 195 Larned street, West Detroit, Mich., make a specialty of building railway motors, dynamos and general electrical appliances. Mr. J. F. Shawhan is the manager of the company, and will give personal attention to all orders placed with them.

An Excellent Opportunity.—Active electrical salesmen desirous of securing a permanent, profitable agency should communicate with the Heisler Electric Light Company, Drexel Building, Philadelphia, as the Heisler Company has increased its facilities for the manufacture of its specialties to an extent that enables it to supply all orders, and will now become active in introducing these specialties.

Jewell Belts in a Large Plant.—The plant of the Rochester Street Railway which was illustrated and described in THE ELECTRICAL WORLD recently is fitted throughout with the Jewell Belting Company's belts. As this is, next to the West End plant in Boston, the largest electric railway plant in the world the selection of a suitable belt for the severe work required is a matter of great importance.

The Eastern Electric Supply Company has secured the sole agency in the United States for Erickson's patent insulating coupling for combination electric light and gas fixtures, made in one solid piece. Its strength is such that it will hold a weight of two tons on one square inch before breaking. It is made in nut form and can be quickly connected to the piping and fixture by the aid of an ordinary wrench. There is no possible chance of grounding the circuit if this coupling is used.

The Walter Hay Manufacturing Company has recently opened an office and shop at 18 to 30 Randolph street, Chicago, fully equipped with all necessary tools and machinery for the manufacture of light electrical and mechanical specialties. Special attention will be given to model and experimental work. They will shortly place on the market an electric bell and annunciator, which can be sold at retail for a lower price than can be obtained at whole sale for other forms of the same apparatus.

The Chicago Electric Manufacturing Company has recently added to its force and machinery, and has now under way a large lot of extra heavy switches, 15,000 porcelain insulators and a number of special volt indicators. The company has now in stock a complete line of copper bar, ranging in size from three-fourths to one and a half inches wide, and from one-thirty-second to one-quarter inch thick, all 60 inches long. A full line of insulating material in rods, sheets and tubes will also be carried.

The Jewell Belting Company has lately made the following installations: The Ball Electric Light Company, of Boston, for McCuller, Parker & Co.; plant of Derby Gas Company, Birmingham, Conn., 100 feet 30-inch 3-ply main belt; Farmington River Water Power Company, 75 feet (countershaft to generator), 35-inch double, this plant being the great water power installation for furnishing electricity to Hartford and vicinity; Western Electrical Construction Company, Denver, two 36-inch double, each 125 feet long.

The Carr Manufacturing Company, of Medford, Mass. calls attention to the Yorkshire boiler compound lately introduced from England, where it has been in use half a century. It is a well-known fact that a scale one-sixteenth of an inch thick requires an extra expenditure of fuel, and as the scale thickens the ratio of cost increases, requiring extra fuel for the year. The above compound is purely vegetable, and as it is sent on trial certainly ought to come into favor. At present several large electric light stations have it in use.

The Central Electric Company, of Chicago, has presented itself with a new set of offices for a Christmas present. On account of the increase in its various departments, the company finds it necessary to have the business divided up so that each department will be in charge of some one person who will give it exclusive attention. The president and secretary, under the new arrangement, each has a private office, which is very neat and attractive, and will repay a visit from any one interested in electrical work who may happen to be in the city. The appearance of the salesroom is also greatly improved.

The Commercial Electric Company, of Detroit, Mich., an electrical engineering and contracting firm, has installed during the past 60 days the following incandescent electric lighting plants: E. S. Fitch & Co., E. J. Hargraves & Son, Green & Braman, Edmund Hall, Bousfield & Co., all of Bay City, Mich.; P. L. Sherman & Co., Linwood, Mich.; A. J. Dougherty, Clare, Mich.; Peninsular Car Company, Detroit; and is now fitting out the laboratory of Parke, Davis & Co. for 500 incandescent lights. Both construction and supply departments are doing an excellent business, and he prospect for the coming year is very favorable.

The Baxter Electric Motor Company, of Baltimore, has already received orders for 50 street railway motors of the improved type, illustrated in the last issue of THE ELECTRICAL WORLD. To receive such a large order so soon after giving a public test of the motor is certainly most gratifying, and will keep the company's factory running to its fullest capacity for several weeks. The necessary magnet wire, mica and armature rings have already been ordered, and the aggregate of the orders given to the general trade amounts to nearly $10,000. Thus it is that every new improvement benefits the various branches of the electrical industry.

Street Car Wheels.—The 12 or 14 new cars of the West End Street Railway about to be put in service, equipped with the Robinson radial trucks, will also be furnished with the new pattern all steel car wheels of the American Steel Car Wheel Company. Several hundred of these wheels are now in service on the West End and have been running from 6 to 12 months or longer, and have made all the way from 8 to 20,000 miles up to the present time. They are still in service, and upon examination show that they are good for much longer service before they receive their first turning which renews them. These wheels are now making an average of 2,000 miles per month.

The Brown & Sharpe Manufacturing Company is sending to its many friends a very handsome paper weight, having a celluloid sheet on which is finely engraved an excellent view of the extensive works wherein are manufactured so many tools of interest to electricians, especially the micrometer calipers, standard gauges, etc. The business now conducted by this company was founded in 1833 by David Brown and his son, Joseph R. Brown. David Brown retired in 1841, and the business was conducted by Joseph R. Brown until 1853, when Lucian Sharpe became his partner, and the firm of J. R. Brown & Sharpe was formed. The Brown & Sharpe Manufacturing Company was incorporated in 1868. The total floor space occupied in 1853 was 1,800 square feet, while the total area of floor space of the building shown in the engraving on the paper weight is four acres.

The sales of Evans' friction devices still continue very large. The following installations are reported: Anhauser Busch Brewing Company, St. Louis, 135-light Edison; Olean Electric Light and Power Company, Olean, N. Y., two 750 Westinghouse alternating, two 60-light Brush, two exciters; A. M. Church Company Ltd., Troy, N. Y., one Westinghouse engine with United States arc and incandescent plant; Bridgeport Electric Light Company, two 45 arc light dynamos; Edison General Electric Company, electric railway for Long Island City; Clyde Electric Light Company, Clyde, N. Y., one 500 National alternating, one 50 arc Western Electric Company; Warren Electric Light Company, Warren, Pa., one Thomson-Houston direct and one 650-light Thomson-Houston alternator; Corcoran Building, Washington, D. C., electric light plant; Hewes & Gawthrop, Pittsburgh, Pa., electric light plant; Edison Illuminating Company, Easton, Pa., 50 arc Sperry; Fall River Laundry, Thomson Houston plant; Russell, Birdsall & Ward, Port Chester, N. Y., No. 8 Edison; Hopedale Electric Car Company, Hopedale, Mass., one 250 h. p. plant for charging storage batteries; this company has also fitted up the New Ames Building, Boston, using two No. 8 Edison dynamos of 275 lights each, all the space occupied by engine and two dynamos being 8 feet by 10.

Business Notices.

Grand Opportunity.—We want active, enterprising agents in New York, Massachusetts, Connecticut, New Hampshire, Vermont, Upper and Lower Canada, Northwest Territory, and all of the Southern States. Electrical engineers or established and progressive supply houses should open correspondence at once, as we have increased our manufacturing facilities to an extent that will enable us to promptly fill all orders for our specialties, as well as for the Heisler long-distance incandescent lighting system complete in all its details.

HEISLER ELECTRIC LIGHT COMPANY,
Drexel Building, Philadelphia, Pa.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED DEC. 30, 1890.

443,493. Telephone; Sigmund Bergmann, of New York, assignor to Edward H. Johnson, of same place. Application filed Dec. 31, 1884. The method of reproducing sound from telephone current vibrations, consisting in passing the electric current axially through a magnet thereby varying its force in conformity with the current changes and moving a sound-producing body by the varying force of such magnet.

443,494. Telephone; Sigmund Bergmann, of New York, Assignor to Edward H. Johnson, of same place. Application filed Oct. 26, 1885. In a telephone transmitter, a diaphragm consisting of a thin plate, a metal rod attached at one end to a centre of said plate and another metal rod held rigidly and making an end contact with the rod attached to the diaphragm.

443,497. High-Resistance Compound; William George Bremer, of St. Louis, Mo., Assignor to the United States Electric Improvement Company, of Gloucester City, N. J. Application filed June 6, 1890. A high-resistance compound, consisting of graphite and shellac.

443,508. Pole-Top for Trolley-Wire Supports; William Le Roy Emmet, of East Rockaway, N. Y. Application filed Sept. 18, 1890. The combination of a metal plug, a plug or block of insulating material attached to the upper end of said pole, a hollow metal top resting upon said plug or block and inclosing a portion of the top of said pole, and a sleeve of insulating material inserted between said pole and said top.

443,526. Telephone; Edward H. Johnson, of New York. Application filed April 24, 1884. In a telephone transmitter, the combination, with one circuit, of two or more sets of electrodes, and definite units of resistance located in shunt circuits around such electrodes.

443,527. Apparatus for Automatically Grounding or Cutting out of Circuit Exposed Electrical Conductors; Francis W. Jones, of New York. Application filed Aug. 15, 1890. A continuous conductor suspended at intervals, in combination with earth circuits located at or near points of suspension and normally open circuit closing devices not normally forming part of the conductor, said closing devices being mechanically connected on each side of the points of support with the aforesaid conductor.

443,530. Socket for Electric Lamps; Charles A. Lieb, of New York. Application filed Sept. 24, 1890. A complete lamp socket made of a single piece of non-conducting material, having conductors and binding screws, passages for the introduction of wires and a threaded recess or hole which does not connect with the interior of the socket, whereby water, gas, etc., is excluded from the interior or contact chamber of the socket.

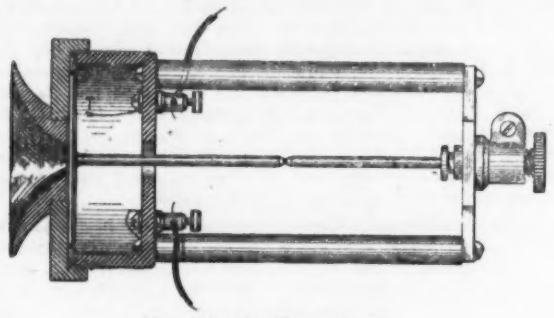
443,556. Secondary Battery; Harry W. Wardwell, of Lake Village, N. H. Application filed Sept. 2, 1890. In a secondary battery, a plate or electrode thereof having cavities formed therein, each cavity being open at one side of the plate and having a bottom at the other side, said cavities being adapted for the retention of active material and a reticulated or lattice work cover, having interstices therethrough, for each of said cavities.

443,557. Arc Lamp; Alonzo Wilton Whitcomb, of Worcester, Mass. Application filed March 27, 1890. In an arc lamp, the combination with arc striking and feeding mechanism, of two releasing devices for the feeding mechanism, one operated by the main current and the other by a shunt-current, and each independent of the other.

443,562. Incandescent Lamp Socket; Sigmund Bergmann, of New York. Application filed Jan. 10, 1890. In a socket, the combination of an outer shell, a bushing of insulating material rigidly secured in the shell and extending its entire length, a cap having a central opening, a disc of insulating material on the inner face of the cap, the inner shell having the inwardly turned flange and the wide side openings, a block of insulating material having opposite notches, binding screws within said notches, and integral tongue extending from the inner shell, independent of the flange to a binding screw, and a resilient contact-piece extending from the other binding screw.

443,565. High-Resistance Compound; William George Bremer, of St. Louis, Mo., Assignor to the United Electric Improvement Company, of Gloucester City, N. J. Application filed Oct. 31, 1890. A homogeneous high-resisting composition or compound consisting of rubber, shellac and graphite.

443,580. Electrical and Vapor Face-Bath; Nathaniel Lyke, of Williamsport, Pa. Application filed April 25, 1890. A



No. 443,494.—Telephone.

face-bath having electrodes on opposite sides, in order that the patient's face being introduced between them may complete the circuit.

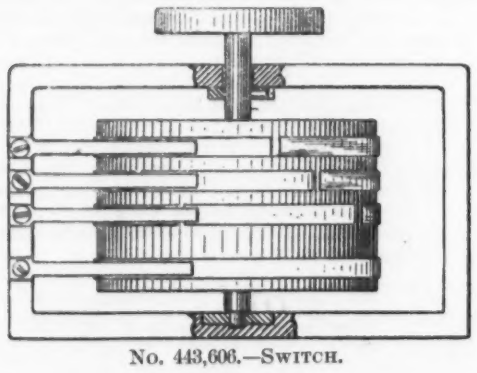
443,598. Apparatus for Preventing Steam Boiler Incrustation; John Langstaffe, of Battersea, England; Story B. Ladd, Administrator of said Langstaffe, deceased. Application filed Feb. 10, 1890. The combination with a positive and a negative electrode, of a disc of finely-divided material secured between the said electrodes and adapted to be suspended in the water space of a boiler.

443,606. Switch; Edward H. Johnson, of New York, Assignor to Bergmann & Co., of same place. Application filed Jan. 21, 1885. The combination, with a movable body of insulating material, of a contact piece carried thereby permanently in connection with the conductor of the main circuit, and two or more overlapping contact pieces carried by and terminating at different points on the surface of the movable body, and consisting of non contiguous strips extending around the movable body, the breaks in the strips being arranged diagonally on the surface, and co-operating contacts for said overlapping contact pieces connected with the other conductor of the main circuit, whereby one or more of the overlapping pieces may be connected with the continuous contact.

443,632. Electric Arc Lamp; Edward Heymann and Frank Wm. Heymann, of Boston, Mass. Application filed Nov. 5, 1888. In an arc-light regulator, a feed rod of magnetic material, in combination with an electromagnet having shunt and main windings, the core of the magnet being mounted axially and extending across the feed-rod and carrying a pole-piece, the magnetism of which controls the feed-rod, and one or more pole-pieces which act with a second magnet to move the controlling magnet on its axis.

443,633. Electric Arc Lamp; Edward Heymann and Frank Wm. Heymann, of Boston, Mass. Application filed Nov. 5, 1888. A regulator for arc lamps consisting of two electromagnets whose energy is controlled by shunt and main currents, the cores being mounted axially crosswise of the feed-pole, the pole-pieces of the cores form rocker-arms and the feed-rods being gripped directly between two opposed pole-pieces.

443,636. Apparatus for Measuring and Registering Electric Currents. Application filed Nov. 1, 1888. In an apparatus for measuring or registering electric currents the combination, with means for creating a magnetic field, of a rotatable or movable conductor arranged to move substantially at right angles to the lines of force in said field, unchanging electrical connections for passing a current in a uniform manner through



No. 443,606.—Switch.

the conductor, and current measuring devices actuated by the conductor, whereby the current passing in said conductor may be determined.

443,642. Electric Meter; Chaimsonovitz Prosper Elieson, of London, England. Application filed March 18, 1890. An electricity meter, having in combination a closed vessel containing liquid through which the current to be measured passes, a vessel having provision for maintaining a liquid at a constant level therein, and for feeding said closed vessel, and a register having connections with said close vessels.

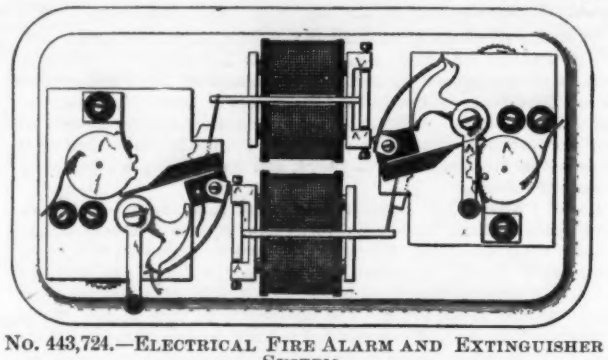
443,646. Magneto-Electric Stop Mechanism; Washington H Kilbourn, of Greenfield, Mass., Assignor to Herbert O. Edgerton, of same place. Application filed June 4, 1890. The combination, with a source of power, of a pulley connected thereto, a driving pulley, a belt passing over said pulleys, a belt-tightener, trip mechanism, an electro-magnetic device for actuating said trip mechanism and an electric circuit including the electromagnetic device and circuit closer.

443,661. Traction and Brake Device for Electric Railways; Rudolph M. Hunter, of Philadelphia, Assignor to the Electric Car Company of America, of same place. Application filed Sept. 23, 1886. The device consists of a helix upon a magnetizing core preferably hollow, and adapted to surround the lower part of the wheel. By sending a current through the coil the wheel is magnetized and attracts the rail, increasing the traction. If said hollow core be allowed to come into contact with the wheel, it acts as a brake. This movement is controlled by a suitable hand lever, and when the brake is applied the traction force also increases, still further assisting in arresting the motion of the vehicle.

443,671. Electric Locomotive; Rudolf Eickemeyer, of Yonkers, N. Y. Application filed Jan. 28, 1889. This invention comprises a car body, driving axle, and suitable gearing, and an electric motor provided with an armature and a shell or casing which constitutes a part of the magnetic system of the motor and in part serves as an effective magnetic shield between the interior of the car or locomotive and the magnetic field developed by the field coils of the motor, whereby watches carried by persons riding on said locomotive are protected against injury by exposure to magnetization.

443,677. Traction and Brake Device for Electric Railways; Rudolph M. Hunter, of Philadelphia, Assignor to the Electric Car Company of America, same place. Application filed Sept. 23, 1886. In an electric railway the combination of a traveling vehicle, an electric motor thereon to propel the same, an electric brake consisting of a magnetizing coil or helix surrounding a portion of a wheel on the vehicle shaft, a brake circuit including said brake helix and means to vary the strength of the current.

443,693. Electric Switch; James J. Wood, of Brooklyn, N.Y. Application filed May 28, 1890. A lever of the first-class having a bearing face extending along it to both sides of its fulcrum, an actuating part movable in a direction longitudinally of the lever to opposite sides of its fulcrum and constructed to exert a yielding tension against the lever, an operating handle for imparting motion to the actuating part, and an interposed spring through



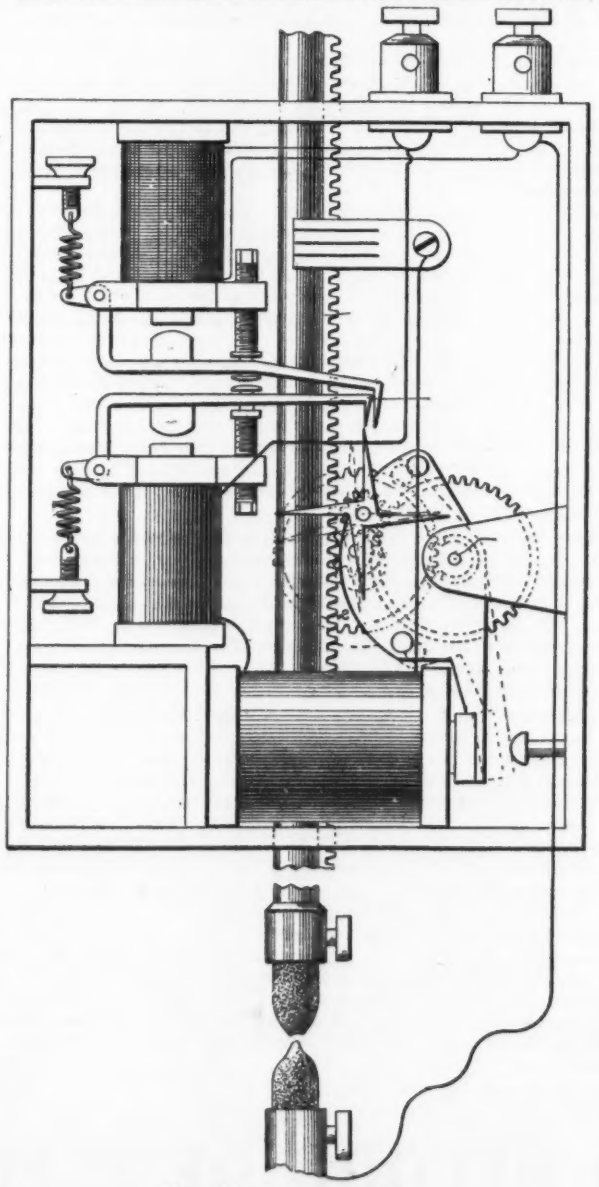
No. 443,724.—Electrical Fire Alarm and Extinguisher System.

which the motion is communicated, whereby in forcing the actuating part toward the position where it passes the fulcrum of the lever, power is stored by the flexure of said spring, and as it passes said position the tension of the spring is exerted to thrust it beyond the fulcrum, so that a thrust sufficient to carry the actuating part over the fulcrum of the lever insures the throwing of the switch.

443,716. Electric Damper Regulator; Jeremiah O'Meara, of New York. Application filed May 2, 1890. An electric regulating device comprising an electric conductor adapted to be expanded by the heat of an electric current and a curcuit-controller for including said conductor in said circuit when conditions extraneous to the circuit render such inclusions necessary or desirable, combined with a damper or other movable device actuated by the expansion and contraction of the said conductor.

443,724. Electrical Fire Alarm and Extinguishing System; Charles E. Ongley, of New York, Assignor of one-half to Thomas W. Robertson, of same place. Application filed April 12, 1890. In a fire alarm and extinguishing system, the combination of a signal-receiver, a duplex transmitter connected therewith, a fire alarm circuit containing a thermostat for controlling one section of said transmitter, an independent circuit from a second section of said transmitter to an automatic sprinkler independent of the fire alarm circuit for controlling said second section of the transmitter, and a non-interference device for the two sections of the transmitter.

443,726. Electrical Signal System; Charles E. Ongley, of New York. Application filed May 13, 1890. The combinati on in a signal system, with a circuit including suitable transmitters, a relay



No. 443,557.—Arc Lamp.

magnet and battery of a receiving apparatus comprising an instrument having two or more operating magnets in separate local circuits or branches, an automatic distributer or switch, a motor therefor, a releasing magnet brought into operation by the first movement of the relay, and means for controlling the distributer.

443,727. Safety Device for Dynamo Stations; Charles E. Ongley, of New York, Assignor of one-half to Thomas W. Robertson, of same place. Application filed June 30, 1890. The invention comprises an engine or motor, a dynamo driven thereby, and a cut out directly in the dynamo-circuit, a local circuit, a device for stopping the flow of current from the dynamo to the cut-out and line, and a magnet in said local circuit controlling said device.

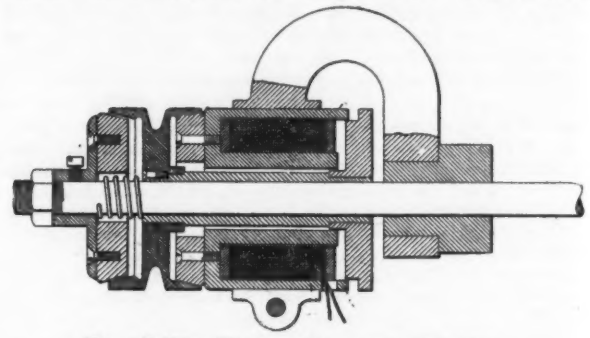
446,746. Electric Lamp Socket; John T. Dempster, of Summit, N. J., Assignor to Bergmann & Co., of New York. Application filed May 24, 1890. An electric lamp socket comprising a metal sleeve, a second metal sleeve within the same and insulated therefrom, terminating in a flange, an insulating block inserted into the outer sleeve and carrying a contact co-operating with the flange, and a second contact.

443,748. Method of Electrically Soldering and Cementing Cans; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation of the same place. Application filed Oct. 4, 1890. The method of electrically soldering or cemen ing together the parts of cans, consisting of suitably applying the solder or cement to the junction of the parts, passing a heating electric current through and between the parts, bringing a tool in contact with the solder or can, and then moving the tool along the junction.

443,749. Apparatus for Electrically Soldering and Cementing Cans; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same place. Application filed Oct. 4, 1890. In an electric soldering or cementing apparatus for cans, terminals of an electric circuit to be applied to the work, and a movable tool for distributing or sweating in the solder or cement at the junction.

443,752. Non-Interfering Signaling System; Charles E. Ongley, of New York. Application filed May 9, 1890. The combination of signal-discs, independent detent-magnets in separate circuits controlled by means of a suitable transmitter, whereby the box or station number may be indicated, and an additional disc, also controlled by the transmitter and a separate circuit and indicating the number of revolutions of the transmitter.

443,772. Electromagnetic Clutch; Charles Edmund Kells, Jr., of New Orleans, La. Application filed March 31, 1890. The combination of a power-driven shaft, a wheel or pulley loosely



No. 443,772.—Electromagnetic Clutch.

mounted thereon, an electromagnet, its armature connections between the armature and the wheel, a spring for holding the armature away from the magnet, a friction-block with which the wheel engages when the armature is withdrawn from the magnet, and a friction collar, with which the wheel engages when the magnet attracts the armature.

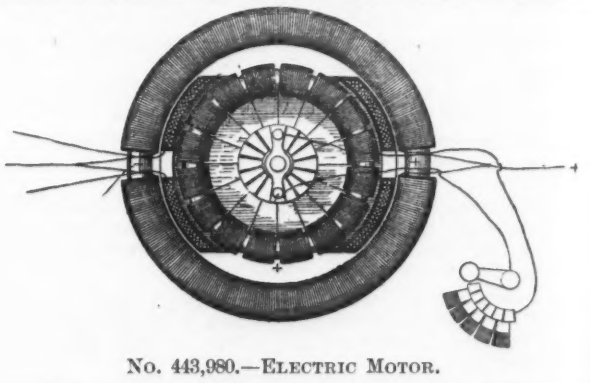
443,789. Electric Valve-Controller; Charles E. Ongley, of New York. Application filed April 4, 1890. The combination, with a main valve operated by fluid pressure and controlling the passage between an inlet and outlet pipe, of a second valve controlling a passage leading from the inlet pipe to a space above the main valve to open it, a magnet, an armature for the magnet, to which is connected a rod, and a valve-rod for the second valve meeting the armature rod, but having no positive connection therewith, whereby the valve and rod may be moved by the armature or independently thereof.

443,790. Electric Protective and Signaling System; Charles E. Ongley, of Yonkers, N. Y. Application filed November, 1889. The combination, with a watchman's time-register comprising time mechanism, type-wheels controlled thereby, printing mechanism, feeding mechanism, and an electromagnet directly controlling the printing and feeding mechanism, of individual-signal transmitters connected in circuit with said magnet.

443,814. Electrical Attachment for Railway Switches; Arthur W. Berne, of New Orleans, La., Assignor by mesne assignments to the Electrical Safety Railway Switch Company, Limited, of same place. Application filed July 5, 1890. In an electrical indicating mechanism for railway switches, the combination, with a railway and a movable switch rail thereof, having a lug depending from its base, of a spring plate arranged beneath the rail and connected with an electric wire, and underground spring plate, connected with a ground wire and adapted to make and break contact with the first mentioned plate by the lateral movements of the switch rail, and bars arranged along the track, the whole adapted to serve with a locomotive carrying an alarm, and brushes connected therewith co-operating with the bars.

443,823. Apparatus for Laying Electric Conductors; Thomas J. Cope, of Philadelphia. Application filed May 22, 1890. The invention comprises the combination of an air chamber, a conduit plug having a tubular stem or pipe extending therethrough, and a flexible pipe connecting said air chamber and stem or pipe.

443,824. Apparatus for Laying Conductors in Conduits; Thomas J. Cope, of Philadelphia. Application filed Sept. 4, 1890. An apparatus for laying electric conductors in conduits, having a head, a tail-piece, connecting rods, a carrier movable in said rods, a pulley on said head, a wedge adapted to move in said



No. 443,980.—Electric Motor.

carrier and also contact with the head thereof, rollers journaled in pivoted arms and adapted to contact with said wedge, and a rope connected with the wedge and passing around the pulley on the head.

443,834. Electrical Annunciator; John W. Luthe and Alfred E. Jeavons, of Cleveland, O., said Jeavons Assignor of one-half to said Luthe. Application filed Jan. 23, 1890. An electrical annunciator comprising a series of differential magnets, the primary coils thereof connecting in common with the battery and connecting, respectively, with the different call-buttons, the secondary coils thereof connecting the one with the other in a continuous closed circuit, and gravity pointers pivoted to the face plate of the annunciator in position to be attracted by the core of the next adjacent magnet.

443,841. Attachment for Electric Arc Lamps; James A. Manning, of Ashtabula, O. Application filed Sept. 24, 1890 A longitudinally divided holder having a groove for the reception of the carbons and a cut-away portion, with a combustible or fusible band lying in the cut-away portion and holding the parts of the holder together.

443,976. Galvanic Battery; George A. Smith, of Halifax, Can. Application filed July 14, 1890. A battery element comprising alternating rows of carbon and zinc rods, bars of conducting material connecting the rods of each row, insulating plates between the upper ends of said bars and transverse bolts passing through said plates and bars and insulated from the bar connecting the zinc rods.

443,980. Electric Motor; Charles J. Van Depoele, of Lynn, Mass. Application filed March 8, 1889. An electro-dynamic motor for alternating or pulsating currents, comprising a wire-wound armature, an electromagnetic system surrounding the armature, for producing magnetizing currents therein by induction, thereby establishing poles in said armature, and a field-magnet arranged to react upon the armature-poles produced by the induction system.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.